amateur radio

Vol. 38, No. 5

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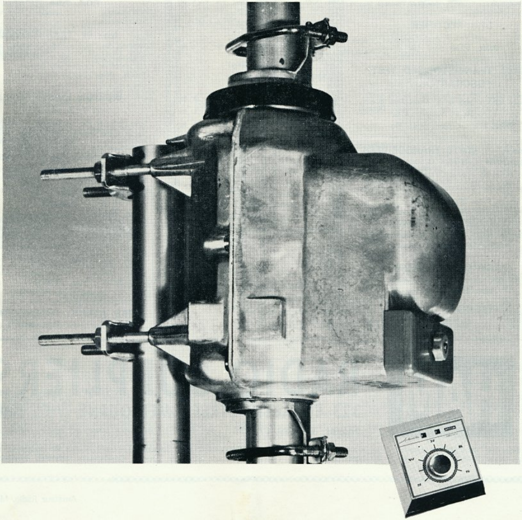

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amateur radio

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CONTENTS

COVER STORY

Our front cover this month shows the up-dated version of the Stolle aerial rotator, with its automatic remote control unit. Full details of this newly developed transistorised rotator may be obtained from the Sole Australian distributor, R. H. Cunningham Pty. Ltd., 608 Collins Street, Melbourne, Vic., 3000.

FEDERAL COMMENT

THE 34th FEDERAL CONVENTION

The 34th Federal Convention of the Wireless Institute of Australia held in Adelaide at Easter was significant both in the decisions that were made and also in the new concept of our organisation that seems to have emerged.

Let me first refer to some of the more important matters discussed, and first amongst those was the question of the 1971 I.T.U. Space Frequency Conference. The Federal Council formulated a detailed policy in relation to that Conference. Fundamental to that policy was the view that the v.h.f. and higher Amateur frequency bands that could conceivably come under attack as a result of the conference should be preserved for the Amateur Service. The Federal Council recognised the importance of the 420-450 MHz. allocation for Amateur satellite use and this is one of the bands in respect of which concern has been expressed.

Les Jenkins, Project Manager of the W.I.A. Project Australis Group, flew to Adelaide to address the Federal Council. He explained the Group's proposals for Australis-Oscar B, the "follow up" project to Australis-Oscar 5. He brought with him a working design model of the package which will be basically a repeater from the 144-148 MHz. band to the 420-450 MHz. band. The Federal Council unanimously expressed its congratulations to the group on their achievement in relation to Australis-Oscar 5 and resolved to support the group's current project.

This decision was indeed significant, for whilst the previous project was basically a University Society project, Australis-Oscar B will be basically an Amateur project.

Many will be disappointed with the result of the voting on Novice licensing. The Federal Executive raised the issue seeking a clear expression of policy in relation to this contentious matter. The Divisions divided equally on the matter and the chair, after ruling that the current policy of the W.I.A. was not to advocate a Novice licence, exercised a casting vote to maintain the status quo as required by the Institute's Rules of Procedure.

However, the door is still not closed, for it was decided by the Federal Council that the Federal Executive should seek reasoned submissions, valid for the current decade, supporting Novice licensing for circulation to the Divisions with a view to the Federal Council again undertaking a review of its policy in relation to this matter.

As was anticipated in the last "Federal Comment", the W.I.A. Intruder Watch was reviewed. It was the clear view of the Federal Council that this activity should be continued as a most important part of the Institute's primary function of protecting Amateur bands.

A report from the I.A.R.U. Region III. Director, John Battrick, was adopted and a number of matters relating to the Region were agreed to. It was decided that the Region III. Conference, forshadowed at the 1968 Inaugural Congress, should be held as soon as possible and before the 1971 Space Services Conference. The New South Wales Division Federal Councillor told the Council of his recent trip to India, Thailand, Hong Kong and Singapore.

Two matters — one initiated by the Victorian Division and the other by the Federal Executive — raised questions of fundamental importance. The Victorian Division suggested that certain routine Divisional functions such as the collection of subscriptions, maintenance of membership and circulation lists and the like could be economically centralised and transferred to an E.D.P. or similar system. The Executive suggested the engagement of a permanent Federal Manager. It was decided that both these matters should be considered together and the Executive has been instructed to prepare a detailed report.

I think the significance of these matters was not so much in the decisions made, but in the acceptance of the principle that the W.I.A. cannot continue to operate on its present limited budget and almost total reliance on voluntary effort. It must plan now for the future and on the basis that it has the capacity to deal with not only the problems of today but also the problems of tomorrow. One felt that it was accepted that in order to remain effective, the Institute must be prepared to rely far more than it has in the past on new techniques and permanent staff. It is no longer a small club of hobbyists and the techniques and finances appropriate to that sort of organisation are just not appropriate to the Institute today. I agree with the delegate who said that as the Institute enters its sixtieth year we must seek a "new look" organisation.

The Convention also gave the opportunity for most Federal Councillors and Federal Executive members to meet for the first time the new Controller, Regularity and Licensing Sub-Section, Mr. H. S. Young. He succeeds Mr. Charles Carroll and comes from New South Wales where he was Superintendent, Radio, for that State.

He came from Melbourne to attend the Dinner on Saturday night, a gesture much appreciated. Also present at the Dinner was the Senior Vice-President of the A.R.R.L., Wayland Groves.

All those attending the Convention paid glowing tribute to the South Australian Division for the manner in which the Convention was organised, particular tribute being paid to the South Australian Federal Councillor, Geoff Taylor.

Looking back on the 34th Federal Convention, it is my view that it was one of the most tangibly useful Conventions in recent years. Time may prove the 1970 Federal Convention to be one of the most important ever when the Institute took the first steps to moving in a new direction.

—MICHAEL J. OWEN, VK3KI,
Federal President, W.I.A.

Modifying the Yaesu Musen FR-100B Receiver

R. D. CHAMPNESS, VK3UG*

THESE receivers are quite good as they stand in my opinion. It is because I find this receiver so satisfactory that I decided I would endeavour to make this good receiver even better. I have now incorporated 160 and 11 metres as well as fitting an n.b.f.m. detector and limiter. I have done one or two other minor modifications to do with the v.f.o. and S meter.

WARM-UP DRIFT

I will start with the minor modifications and then on to the more elaborate ones. An overseas Amateur suggested this first one and his claim seems to be substantiated. Wire a resistor of about 270 to 470 ohms in series with the cathode lead of the oscillator section of the v.f.o. valve. The resistor and L20 are then in series and the coil tap comes off the junction of these two components. This seems to reduce the drift of the v.f.o. during warm-up.

S METER

Another modification, which won't impress the chaps who like to give S9 plus plus plus readings on the S meter, is to de-sensitise it. To do this, put a 6.8K ohm resistor in place of the series meter resistor R44 (a 1K ohm resistor). Like most S meters, the Yaesu Musen is optimistic, even with this modification although it is much more realistic, and most ranges give a reading of S9 corresponding to 100 μV. I was lucky enough some time back to have access to an accurate signal generator and so I made a chart up so if necessary, I can give relatively accurate strength readings.

AUDIO

A simple way to reduce the high overall audio gain and to improve the audio quality is to remove the cathode by-pass capacitor on the 6AQ5 audio output valve. The distortion at 1 watt output is 4% and the frequency response is —3 dB. at 200 Hz. and 4,500 Hz. with 0 dB. at 1,000 Hz. reference. This is only the audio response and does not include the various filters.

SWITCH-ON SURGE

To reduce the switch-on surge and so allow a smaller fuse, a CZ9A thermistor was wired in series with one of the 240 a.c. leads. I can now use a ½ amp. fuse.

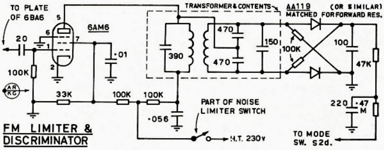
F.M. LIMITER AND DISCRIMINATOR

The FR-100B has provision for an f.m. limiter and discriminator, but, unfortunately, these don't seem to be available. The one I am about to describe is, I feel, slightly cheaper and they are all Australian parts.

* 24 O'Dowds Road, Warragul, Vic., 3820.

To accommodate this section, the power supply filter choke was moved to the top of the chassis, between the 12AU7 and the 455 KHz. i.f. transformer near the power transformer. By doing this, much more space under the chassis was available for the f.m. system.

The 7-pin valve socket is mounted in the hole provided, but the discriminator transformer which I used was much smaller than the intended Yaesu unit. I made up a small plate for the transformer to sit on and then bolted this to the mounting holes of the original Yaesu transformer. The transformer I used was a type used in a Pye Victor MVF529 f.m. transceiver. The part number is 087-000-183. Possibly other makes could suit, but remember it must be 455 KHz. 30 KHz. channel unit.



FM LIMITER & DISCRIMINATOR

Having mounted the valve socket and transformer, the signal input and output sources must be located. The input to the 6AM6 comes via a 20 pF. from the plate circuit of the last i.f. amplifier —a 6BA6. This capacitor is actually already wired to a tag strip, ready for you to extend to the grid of the 6AM6. The output line is in the corner on a 3-lug tag strip near the discriminator transformer. Incidentally, the red pin of the discriminator transformer is the plate lead, and by continuity measurements, the other leads can be ascertained. This is a perfectly standard limiter-discriminator.

The resistor values should be adhered to but the screen and plate by-passes are not all that critical. The value of the 0.47 meg. resistor may need to be altered slightly to obtain a same level of audio from a signal deviated 3 KHz. compared to an a.m. signal modulated 100%.

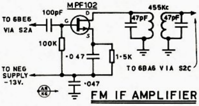
To check how well the f.m. system operates, should you have an f.m. carphone with 4 MHz. transmitter crystals, tune to the 7th harmonic in the 28 MHz. band and listen to the 3 KHz. deviated audio, it sounds very nice. You will have to couple a wire close to one of the multipliers about the envelope. This is also a good way of checking your f.m. transmitter.

EXTRA I.F. STAGE

I found on the lower bands that the i.f. system in the f.m. mode seemed to lack gain, the S meter would read several points lower on f.m. than on a.m. This I concluded was due to mismatching in the coupling system between the 6BE6 converter and the 6BA6 first i.f. I tried various coupling methods with partial success, but eventually concluded that an additional i.f. stage was needed.

Much to many solid state merchants' amazement, I imagine, I used an MPF-102 FET in an i.f. amplifier. The FET amplifier was wired into the circuit in only the f.m. position. The i.f. transformer is an old small A.W.A. battery receiver i.f.

The input of the amplifier goes to position 6 of S2A and the output to position 6 of S2C, removing the bridging wire between these two contacts. The amplifier provides a reasonable amount of gain and the selectivity of the complete i.f. strip in the f.m. condition is about ±10 KHz., so at least 7 or 8 KHz. deviation should be quite okay through this unit.



FM IF AMPLIFIER

The FET amplifier was built on a piece of veroboard about 1" square and the transformer was mounted alongside the mechanical filter. The value of the source resistor may need to be experimented with to get optimum gain. The supply voltage is taken from a small voltage doubler off the filament line.

ALIGNMENT

The alignment of the discriminator is a bit different from the f.m. carphones that most of us seem to have,

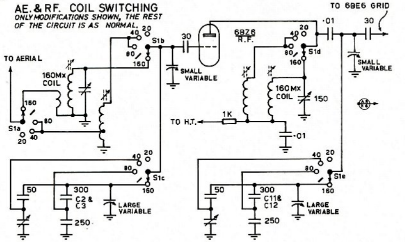
so here is the alignment data. Adjust secondary top core of the discriminator for zero reading on the meter at the junction of the 47K and 470K resistors. Make sure that on adjusting core each side of zero, reading goes positive one way and negative the other. A 50 μA. meter will be satisfactory.

Detune to negative or positive side 20 μA. and screw in primary core (bottom core) until reading dips slightly. Re-adjust for zero reading and check that on shifting either side of 455 KHz. that meter alternates. If it does not seem very symmetrical, try adjusting again but take the secondary core in the direction giving opposite polarity to your original setting.

per instructions in the Yaesu manual. The performance is quite fair, although there is a slight spurious response possibly due to the crystal being on half the required output frequency.

The modifications for 160 metres are much more difficult to accomplish as three coils need to be wound and mounted and some alterations are necessary to the switching for 80 and 40 metres.

The simplest part to do is the fitting up of the crystal oscillator. A crystal of 7,453.5 KHz. is needed and is fitted into the position for Band C. I used Band C as it is the nearest to the 80 metre position seeing as the switch can go full circle. The Band C coil had to be rewound with 20 turns wire about 24 B. & S. and resonated with 100 pF. to tune $7\frac{1}{2}$ MHz.



Modifications to r.f. and aerial coils for operation on 160-80-40 metres. The switch position between 160 and 80 is the position on the switch where the common terminal of the switch contacts no other terminal, i.e. this occurs when the switch indicator dot is at 6 o'clock.

On doing this modification and fitting 160 metres I found that at about 1825 KHz. there was ferocious hash at about S7. I eventually traced this to the limiter, which acts as a class C stage and was generating harmonics, the 4th being in the middle of 160 metres. To overcome this, I had to switch off the limiter when it was not required.

I was not particularly keen to belt a hole in the front panel to accommodate this switch and there was not any spare lugs on the mode switch. On examination of the noise limiter switch I found that it consisted of two sections paralleled. I freed one section of the switch of its a.n.l. duties and wired it to the h.t. supply for the limiter. With the a.n.l. off, the limiter has h.t. applied. My reasoning going as follows: that on f.m. the f.m. limiter will take care of all noise, I hope, and on a.m. in many cases the noise limiter is pretty nearly always required.

EXTENDING RANGE

I decided to fit 11 metres and 160 metres to the receiver and this is how it was done. On Band A I fitted 11 metres. A crystal of 16,425.6 KHz. was fitted to the appropriate socket, the appropriate oscillator coil wired in and the aerial and r.f. coils also wired as

The 160 metre coils are wound on $\frac{1}{4}$" or 5/16" diameter slugged formers with 70 turns of 38 B. & S. enamelled wire wound over $\frac{1}{2}$". I wound these two coils a bit higgle-piggle, but the cores will tune out any variation in inductance. The aerial coil primary consists of 10 turns about 24 gauge wire wound on at the cold end of the secondary. I fitted these coils in the bulkhead between the coil switching sections and the section housing the filter choke and filter capacitors.

One word of warning. **Do** take out all low frequency crystals in the set otherwise you may be unlucky like me and damage a couple beyond repair with the vibration of hole drilling and filing. **Be warned!**

The actual wiring alterations are perhaps better understood by studying the actual final circuit and comparing it with the original. In the original Yaesu circuit, switch S1 should progress from left to right as S1A, S1B, S1C, but in fact on the diagram it is shown as A-C-B.

Capacitor C2 is removed from its original position and paralleled with C3, and likewise C11 is removed and paralleled with C12. One additional 50 pF. capacitor for each section is now required in addition to the two coils. That is all the extra parts needed.

The wiring as I said will become evident on studying the circuit. Both 80 and 40 metres will need some re-alignment after this modification. The preselector is set at about position 1 on 160 metres and the coil cores are peaked for maximum response at 1500 KHz. The trimmers are peaked at 2.1 MHz. after peaking the preselector. The tuning range of the 160 metre coils is from 1.5 MHz. to 2.1 MHz., and the red dial calibrations give the tuned frequency.

Broadcast stations come in quite well between 1500 and 1600 KHz. The University of the Air is quite good on 1750 KHz. On the front panel of the receiver I have marked in red paint Band C with the numerals 160 and Band A the numerals 11 in black. This helps to identify the band, and it does not look unsightly if done neatly. The re-sale value of your receiver will not be spoilt by these modifications because the re-sale value of radio equipment is not high anyway, so why not make your equipment do what you want it to do.

I'll get an aerial up for 160 metres as soon as circumstances permit and put my 130 watt a.m. rig to some use. I hope these modifications are of interest, and some use to others.

AUSTRALIS OSCAR 5 INTERIM REPORT

By OWEN MACE

Australis OSCAR 5 is now silent, its batteries discharged after a working life of six weeks. The work of collecting and processing the thousands of reports from Amateurs around the world begins. Before the last report on AO5 is written, many hours of computer time will have been used in processing the data received from Amateurs. Concurrently with this work, the next Australis satellite is being planned and designed.

AO5 was launched at 1131 GMT on 23rd January, 1970, in what could only be described as a flawless, text book launch. One hour later, Australis separated from the Delta second stage and its two transmitters switched on. 5R8AS reported hearing the v.h.f. beacon a few minutes later as the satellite came into range of his Malagasy Republic QTH. Minutes later as AO5 passed over Europe, DJ4ZCA and DL-3OJ heard the 10 metre beacon. In the following few orbits, Australis was heard by Amateurs in the U.K., U.S., New Zealand and, of course, Australia.

The response of U.S. Amateurs, especially, is staggering. Many thousands of reports have been received by the project to date. Some tracked every orbit in range throughout the life of AO5; some reported extraordinary antipodal propagation effects, and one even correlated the horizon sensor signals with cloud formations derived from weather satellite pictures, during the later part of the v.h.f. transmitter's life. The patience of one brave soul is attested by this log entry:

> "On orbit 181/182, I could hear the 10 metre signal just about all the way around the world. I heard it for 95 of the 115 minute orbit, from very faint to fairly strong signal strengths."—WA4JID.

WA2KSB heard the 29 MHz. transmitter commanded off during orbit 61 on 28th January.

At the Project Australis headquarters station (VK3AVF), teams were organised to track the two high elevation passes each morning and afternoon. This vigil was maintained until the v.h.f. beacon ceased transmissions during orbit 280 on Saturday, 14th February, after 3½ weeks of highly successful operation.

The magnetic attitude stabilisation system (M.A.S.S.) worked very well also. The satellite was soon locked to the earth's magnetic field by the m.a.s.s. magnet. So accurate was this tracking that, by 10th February, the signal strength of the v.h.f. beacon was appreciably lower as the satellite was south of the city, than when it was north. This was caused by the transmitting antenna becoming unfavourably directed by the earth's field as the satellite moved. Future designs will undoubtedly allow for this unplanned tracking accuracy!

The accompanying article by Jan King describes some of the preliminary results from Australis. In the ensuing months Project Australis will be analysing all the reports received in considerable detail to determine the effectiveness of the design procedures in order to incorporate modifications to the next satellite. Any reports are welcomed, so, if you have not already sent in your reception reports and station resume, please do so. The address is:

Project Australis (Telemetry),
C/o. Melbourne University Astronautical Society,
Union House,
University of Melbourne,
Parkville, Victoria, 3052.

NEXT AUSTRALIS-OSCAR B

Work is proceeding with the design and testing of the next Australis. It is envisaged that there will be six main sub-systems; **the main experiment, the repeater.** While other groups, notably DJ4ZCA, are in favour of linear translators, it is strongly felt by the Australis group that the next step ought to be a hard-limiting f.m. system. Thus Project Australis is working towards a multi-channel, channelised f.m. repeater. The plan is to use one receiver to mix to some convenient i.f. stage, split to several separated i.f. filters and detect down to base band. Then each demodulated signal can then be used to frequency modulate its own carrier which is amplified and radiated. This system allows a number of advantages in that signal processing of the baseband is possible (e.g. speech compressing and a.l.c.) as well as removing doppler shift from the up-going signal. It is presently planned to use about six channels, receiving on 2 metres and transmitting on 432 MHz.

Telemetry System.—It is hoped that a 60-channel telemetry system will be accommodated on the next satellite. Its output will be in the form of teletype signals impressed on one of the repeater transmit channels and operated on command.

Command System.—A 35-channel command system will be incorporated to allow switching of receivers and transmit channels. This will allow great flexibility and will allow failed subsystems to be removed from the repeater system.

M.A.S.S.—It is possible that a magnetic system similar to that carried by AO5 will be incorporated, although a gravity gradient stabilisation has been mooted by Amsat.

Power Supply.—A 6-watt solar powered battery is under investigation by Amsat, who will be responsible for the power supply.

Package.—This is the responsibility of Amsat.

The design is for a lifetime of one year, to 85% confidence. It is anticipated that a prototype of the system will be flown on a balloon from Mildura in the near future, and interested Amateurs are asked to listen to their W.I.A. broadcasts for further details.

AMATEUR FREQUENCIES:

ONLY THE STRONG GO ON—SO SHOULD A LOT MORE AMATEURS!

AO-5 EXPERIMENT RESULTS

By JAN A. KING, K8VTR, Project Manager

The long wait to put Australis Oscar 5 into orbit and the months of hard work to plan, construct, and qualify the satellite have been rewarded by a multitude of useful scientific and engineering information received from Amateurs around the world.

In the rather short lifetime of the 2 metre transmitter (23 days) a number of firsts were achieved by the tiny spacecraft. Several hundred telemetry coding forms and associated reports have been received to date by Amsat, with reports still coming in at a somewhat slower rate. Several hundred more reports were sent to Project Australis where data is being analysed.

This article reports on the operation of the various experiments separately, although they are all somewhat related to one another.

THERMAL BEHAVIOUR OF AO-5

The temperature of AO-5 at ejection from the second stage of the Delta vehicle was 20°C. despite its proximity to a very hot engine and a very cold nitrogen gas jet during launch. The temperature, however, began to rise during orbits 1 through 10, and then stabilised internally at 43°C. ±3°C., where it remained for the duration of the satellite's useful life. This temperature is fairly high, although it does not exceed the maximum design temperature of 45°C. The effects of this higher temperature were, unfortunately, all adverse. Battery lifetime was somewhat shortened during the initial phase of discharge; but worse than this, the 144.05 MHz. beacon power dropped off faster with decreasing supply voltage due to the decreased efficiency of the r.f. power output transistor.

External temperature measurements were higher in sunlight and cooler during eclipse periods as observed by many reporting stations. As the spacecraft entered the dark portion of the orbit, the skin temperature dropped from its 55°C. average to about 42°C. The internal temperature, however, remained fairly constant, dropping only 2 to 3 degrees during the entire eclipse period. Our thanks to W0PGP, K2SS and others for their data in this area.

The spin rate about the X-axis in later orbits became quite slow so that the skin sensor located on the Z surface showed changes in temperature as parts of the satellite rotated in and out of its own shadow. This data was most useful in determining the roll rate about the stabilised axis. W5CAY reported this data for many orbits between 100 and 250. Skin temperature data indicated a spin period of 7 to 8 minutes about the X-axis.

POWER SYSTEM

The spacecraft battery voltage decreased with time very nearly as predicted by pre-launch testing of individual cells. It is felt that the actual voltage dropped off slightly faster than the predicted curve for two reasons. First, the higher temperature accelerated the voltage producing reaction in the batteries. Second, an additional 16 mA. of current was drawn by the batteries; this may have been caused by the failure of the 10 metre modulator which was observed during the third orbit.

M.A.S.S. AND THE HORIZON SENSORS

Possibly the best operating system on board the spacecraft was not electronic at all. The magnetic attitude stabilisation system worked better than some of us had anticipated. Early reports indicated that nulls occurred in the 2 metre signal about once every 15 seconds, making decoding very difficult. The horizon sensors, which were found to be more sensitive than anticipated, changed wildly as they encountered the earth or its atmosphere. By the third day the spin rate had definitely decreased and by orbit 100 the stations in the Washington D.C. area reported that the signal fades on 2 metres did not occur during an entire pass of 15 or 20 minutes.

Activity on the horizon sensors had been greatly reduced, particularly the X-axis sensor. This effect was not entirely expected and can only be attributed to the effective hysteresis damping of the ferrite rods included in the satellite. The effectiveness of these rods was measured at the Goddard Space Flight Centre magnetic test facility and was observed to be very small compared to the strength of the magnet itself. There is question in my mind why they seemed to work so well in space! W5CAY and W0GCH have both shown data to support a roll period about the X-axis of 7.5 minutes.

If you were listening to data on channels 2, 4 and 6, and thought the satellite had cracked a transistor or two, please be advised that all was well. The sensitivity of the sensors allowed the spacecraft to detect the brightness of the earth's atmosphere. The sensors thus slid from a lower to a higher tone as the AO-5 acquired the atmosphere and then the earth. During later orbits when the spin was reduced the variations in sensor frequency were attributable to variations in local cloud cover brightness. (How about that—an Amateur weather satellite!) If a fast discriminator was used to code telemetry, a very fine cloud structure could be revealed during periods of adequate signal strength.

COMMAND

During the first five days of operation the spacecraft was not successfully commanded despite several attempts by both Australian and U.S. stations. AO-5 was successfully commanded to turn off its 10 metre beacon on orbit 61 by station "Tango", WA1IOX, of the Talcott Mountain U.h.f. Society, which is a member club of Amsat. This is believed to be the first time an Amateur satellite was commanded successfully, and Bill Dunkerley, WA2INB, has the distinction to be the first to accomplish this.

The Project Australis group was successful in issuing three more successful commands when the satellite next passed into their range. The power used by the Australians was approximately 20,000 watts effective radiated power (e.r.p.). From that time commands became easier to execute. The original schedule was then kept with week-end operation only on 10 metres until the 2 metre beacon reached end of life. At that time the 10 metre transmitter was turned on continuously. The last commands were sent using only 5 kw. e.r.p. and were executed with no difficulty. The change in apparent sensitivity to command is also attributed to the effective stabilisation of the satellite.

PROPAGATION EXPERIMENT

Despite the unexpected failure of the 10 metre modulation on orbit 3, many useful results were obtained from the 10 metre carrier. The carrier was detected by many Amateurs after the 2 metre signal deteriorated and until 10th March, 1970, when AO-5 officially became space junk item number 1970-008B. The lifetime of this beacon was coincident with several interesting ionospheric events including high activity in the polar regions, a solar event, and most interestingly, a major solar eclipse. All data pertaining to this experiment has not yet been evaluated, but a brief summary of the available results follows:

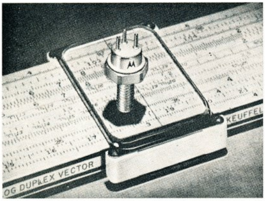
(1) The most commonly observed 10 metre effect was a rapid fading occurring as fast as once every 2 seconds, but more typically once in 5 seconds. This was probably caused by Faraday rotation of the plane of polarisation of the signal.

(2) The 10 metre signal was usually acquired 1 to 2 minutes prior to the 2 metre signal and was lost several minutes after 2 metre LOS; this sometimes occurred as much as 20 minutes later than predicted (on ascending nodes). This is thought to be due to ionospheric skip propagation.

(3) Antipodal reception, while still not predictable, is definitely a real phenomenon. Several reports of such reception have been received. In some instances two signals were reported, one from the spacecraft as it was going away and one as it was heading toward the observer. The signals were appropriately Doppler shifted. On the day of the solar eclipse antipodal reception was reported by three stations on the East coast of the U.S. at approximately the same time.

(4) In general, it should be possible to correlate many of the reports with the state of the ionosphere. Reports are currently being studied.

I hope everyone who participated in the AO-5 programme found it to be an interesting and worthwhile experience.



HOW TO USE R.F. POWER TRANSISTORS*

A guide to the practical use of r.f. power transistors in Amateur Radio equipment, including circuit design, matching networks and construction

PAUL FRANSON, WA7KRE

EVER since transistors were announced many years ago, Amateurs have been interested in using them in all types of equipment. Though the advantages of transistors have made them popular for all electronic applications, transistors are especially suitable for portable equipment. Transistors, with their high efficiencies, small size, low heat dissipation, low voltage operation and high reliability, are ideal for portable gear. Many low-power transistor transmitters have appeared in Amateur magazines, and every circuit of this type that has appeared has attracted considerable attention. Unfortunately though, many of the transistors used in these transmitters are really not ideal for this use, since they are switching transistors or low-power amplifiers that don't perform very well in r.f. power service. Higher power transmitters using r.f. power transistors have rarely been described, and most of the circuits that have appeared really couldn't be considered very practical for most Amateur use.

Old r.f. power transistors suffer from four major faults that have limited their usefulness; low gain, limited power output, high cost, and perhaps most discouraging, susceptibility to destruction due to mismatch or detuning. This last was especially bad in mobile applications where parking too close to a vertical pipe or having your antenna touch a tree could blow out an expensive power transistor if you happened to be transmitting at the time. Various complex schemes were developed to prevent this from happening, but most were not completely satisfactory. Fortunately, new transistors overcome most of these faults.

As you probably realise, the market for transistors in Amateur equipment is miniscule compared to the market in the mobile communications equipment used in police cars, ambulances, taxicabs, and so forth, not to mention the transmitters used in aircraft and military equipment. However, the Amateur benefits from the improvements that result from developing new transistors for these applications. Because these markets are large and growing, transistor manufacturers have been developing highly improved transistors for these uses.

These new power transistors have higher gain and higher power output than earlier devices (up to 100 watts in one transistor at 175 MHz.). They are also rugged and can withstand detuning and mismatching that would destroy earlier devices. Their cost is reasonable for the applications they are intended for. While prices are still high compared to vacuum tubes which can supply the same power, the advantages of transistors have made them the overwhelming choice in new applications. Very little new communications equipment for mobile use is presently being designed with vacuum tubes.

For applications that require high efficiency, small size, and high reliability transistors are used even when they are quite a bit more expensive than equivalent types. For instance, in aerospace communications, literally dozens of transistors are used in parallel in some applications to obtain very high output.

In spite of this, transistors are not replacing vacuum tubes in all applications. The Amateur operator who wants to put out 2,000 watts is not likely to use transistors except in the driver stages where the transistor can make a very compact and efficient assembly.

At the present time, low-power transistors are quite reasonable. For higher power a few devices are now becoming available on the surplus market. Most of them are not modern transistors, and suffer from many of the faults that I mentioned before, particularly failure due to mismatching or detuning. Nevertheless, they are quite useful in many applications and are a very good way to get your feet wet in r.f. power before you take on a more expensive project.

For that matter, dedicated Amateurs have never had any real problems in obtaining components for their projects. The serious Amateur who wants to build a high power transistor transmitter can likely get the transistor he needs one way or another, just as he has been able to obtain expensive varactors for microwave use. And even though the transistors are relatively expensive, they are quite reasonable when you consider their advantages; using transistors that operate directly from a car battery, for example, eliminates the need for a relatively expensive, space-consuming inverter.

The principles outlined in this article apply equally well to small transistors used in 1 and 2-watt transmitters and to the large transistors that are necessary to get 100 watts or more of r.f. power output. The same design principles are used in all of these applications. The numbers will change, of course, and sometimes the networks used for coupling between the transistors will also change due to the differences in impedance levels. However, if you learn how to design a low-power transmitter you can apply the same principles when higher-power transistors become available to you.

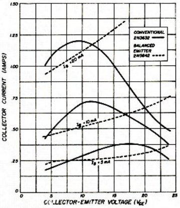


Fig. 1.—Comparison of collector current vs. collector-emitter voltage in conventional and resistor-stabilised transistors (balanced-emitter transistors).

CHARACTERISTICS OF R.F. POWER TRANSISTORS

Modern r.f. power transistors are made of many individual small transistors in parallel. These transistors are formed at the same time in the manufacturing process. The small transistors are then connected in parallel with aluminium metal that is deposited on the surface of the silicon chip. Each of the small transistors handles relatively little power, hence, can be rather small in size. This is an advantage in high-frequency use.

* Reprinted from "Ham Radio Magazine," January, 1970.

A further development of this type of construction is the balanced-emitter transistor. Here a small resistor is placed in series with the emitters of the small transistors that are connected in parallel to form the whole transistor.

Fig. 2 shows a typical balanced-emitter transistor. It is the Motorola 2N5637 which can supply an output of 20 watts at 450 MHz. This transistor consists of 220 transistors in parallel, and is stabilised by 220 small thin-film Nichrom resistors. This device, which is more complex than most ICs, is 50 by 100 mils. (0.05 by 0.1 inch) in size. You'll notice that the 2N5637 is made of ten cells. Similar cells are used in other transistors; the 2N5636, which is often used as the driver for the 2N5637, consists of six cells and can provide 7.5 watts. The 2N5635 contains two cells and can put out about 2.5 watts.

The reason for this complex construction is that it improves ruggedness. If one small transistor in the large chip starts drawing more current than another one because of some small difference in its construction, the current through it would increase. Then the voltage across the small resistor would increase, increasing the emitter-base voltage. This reduces the amount of current that this individual transistor draws. In other words, it is a self-stabilising operation. No single transistor can draw an excessive amount of current. This protects the transistor from secondary breakdown and permits it to stabilise itself in the event of severe load mismatch or circuit detuning.

Since these small emitter resistors are in parallel, their equivalent resistance is very small and does not result in significant degeneration or loss of gain. On the other hand, if a conventional, older type of power transistor is used with emitter-resistor protection, a resistor large enough to have any significant effect on the ruggedness of the transistor circuit would cause considerable loss of gain and output.

The greatest advantage of balanced-emitter transistors is their ruggedness. A balanced-emitter transistor can stand an infinite v.s.w.r. for a short time in a.m. service, for example. You can also tune one of these transistors without having it blow out, as often happens with older transistors.

Another result of this construction is shown in the I_C/V_{CE} curve shown in Fig. 1. Here the collector currents of two transistors with similar output capability are compared. One is a balanced-emitter transistor, the 2N5642. The other is a more conventional transistor, the 2N3632. The 2N3632 contains two chips in parallel in one package, but no emitter stabilising resistors are included in this transistor. You'll notice that as the voltage increases in the balanced-emitter transistor, the current increases proportionately. This shows the excellent linearity which would make it ideal for amplitude modulation or linear amplification. The 2N3632 has a negative resistance region when increasing the voltage results in lower current. This negative resistance region would result in very poor upward modulation, of course, and high distortion in amplifier service.

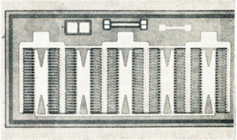
While most silicon transistors, particularly power transistors, are NPN devices, PNP r.f. power transistors are also made by Motorola. One, the MM-4023, is a balanced-emitter transistor capable of 40 watts output at 175 MHz. The lower-power 2N5160 is a close PNP match of the popular 2N3866 and can be used in complementary service (see Fig. 3).

Table 1 summarises a number of r.f. power transistors, both conventional and balanced-emitter types. The conventional ones are suitable for low power stages, for drivers, and where they will not be subjected to load mismatch or detuning. Some of these transistors are also becoming available at relatively low prices in surplus. However, only balanced-emitter transistors are recommended for use where they will be modulated, where any significant power is being handled, or for feeding an antenna. Fig. 4 gives test circuits for some of the transistors. Many of these circuits can be adapted for use in the Amateur bands.

TYPES OF OPERATION

Amateurs are interested in r.f. power transistors for four modes of operation: c.w., f.m., a.m. and s.s.b. The simplest of all of these is c.w. operation. Keyed c.w. can be used in portable operation where the maximum range is desired. There's no question that this operation provides you the best range for a given power. A continuous signal can also be used for driving varactor multipliers or vacuum tubes. F.m. operation is the

Fig. 2.—The geometry of a Motorola balanced-emitter (resistor stabilised) transistor, the 2N5637, which is capable of 20 watts ooutput (minimum) at 400 MHz. The 2N5637 is composed of 220 individual small transistors connected in parallel, each emitter. This construction provides excellent safe area and resistance to damage from detuning or high v.s.w.r.



Type	Supply Voltage (c.w. service)	Gain (min. db.)	P_{OUT} (min. W.)	@ f (MHz.)	Case	Single Quantity Cost
2N3866	28	10	1	400	TO-39	$US2.25
2N3375	28	8.8	7.5	100	TO-60	10.80
2N3553	28	10	2.5	175	TO-39	4.37
2N3632	28	5.9	13.5	175	TO-60	12.75
2N4072	13.6	10	¼	175	TO-18	2.25
2N4073	13.6	10	½	175	TO-5	2.70
2N4427	12	10	1	175	TO-39	2.15
2N5160*	28	8	1	400	TO-39	6.75
2N5161*	28	8.75	7.5	175	TO-60	18.75
2N5162*†	28	6	30	175	TO-60	27.00
2N5635†	28	6.2	2.5	400	144B	7.50
2N5636†	28	5.7	7.5	400	144B	22.80
2N5637†	28	4.6	2	400	145A	57.50
2N5641†	28	8.4	7	175	144B	6.40
2N5642†	28	8.2	20	175	145A	21.30
2N5643†	28	7.6	40	175	145A	40.40
2N5644†	12.5	7	1	470	145A-01	11.80
2N5645†	12.5	6	4	470	145A	15.50
2N5646†	12.5	4.7	12	470	145A	29.20
2N5589†	13.6	8.2	3	175	144B	6.10
2N5590†	13.6	5.2	10	175	145A	14.40
2N5591†	13.6	4.4	25	175	145A	25.20
MM1552†	27	7.8	75	150	145C	67.50
MM4018*†	12.5	10	½	175	TO-39	2.20
MM4019*†	28	10	2.5	175	TO-39	6.50
MM4020*†	12.5	11.5	3.5	175	208-1	8.05
MM4021*†	12.5	7.0	15	175	208-1	19.50
MM4022*†	12.5	5.5	25	175	208-1	30.00
MM4023*†	12.5	5.4	40	175	208-1	49.40

* PNP.
† Balanced-emitter transistor.

Table 1.—Typical r.f. powe' transistors.

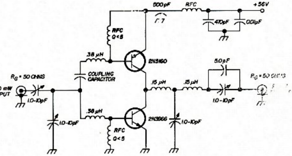


Fig. 3.—300 MHz. complementary r.f. power amplifier using an NPN 2N3866 and PNP 2N5160 transistors.

same as c.w. as far as a transistor is concerned. The deviation used in any type of Amateur or commercial commercial work is so small that it appears as a constant signal to the transistor.

In either c.w. or f.m. operation the transistor can be operated at a supply voltage of slightly less than the collector-emitter breakdown voltage (BV_{CEO}). For example, the 2N5641 series of transistors has a minimum BV_{CEO} of 35 volts and it is quite suitable for use at 28 volts for f.m. or c.w. operation. Likewise, transistors with an 18-volt BV_{CEO} can be used with the automobile supply, which is roughly 13.5 volts. Because you can operate relatively close to the breakdown voltage, you can get maximum power output from a transistor in c.w. or f.m. operation.

Incidentally, the collector voltage of a transistor rises to roughly twice the supply voltage during the cycle. This would seem to exceed the transistor ratings, but this is not true because the radio-frequency breakdown voltage is considerably higher than the d.c. voltage breakdown. It is very close to the highest maximum rating normally given on a transistor data sheet, the BV_{CES}.† The BV_{CES} is 65 volts for the 2N5641 series.

Operation of a transistor at 28 volts requires an inverter if it is used in a car. This inverter can be relatively simple—even an autotransformer that provides voltage doubling. However, this partly negates one of the great advantages of using transistors: the fact that they can be operated directly from the 13.6 volt supply voltage. These 28-volt transistors are quite useful in fixed-station operation, but they are more often used in a.m. service. A transistor operated at its maximum c.w. output, say 40 watts for the 2N5643, must be given some type of protection in case of extended detuning or mismatch. The transistor can survive a short fault but not a continuous one.

Transistors are available for operation from a car battery of 13.5 volts. They are quite similar to the higher-voltage devices but are optimised for maximum output at the lower voltage, and have lower breakdown voltages. They also have lower gain at the lower voltages. For example, the 2N5591 has an output of 25 watts at 175 MHz. when operated directly from a 13.5v. supply. Its power gain at this level is only 4.4 db. minimum, which is relatively low. The 2N5642, which has roughly the same output, 20 watts at 175 MHz., has a gain of 8.2 db. when it is operated at 28 volts. Because of this lower gain, more stages are generally required for the same power level with low-voltage power supplies.

AMPLITUDE MODULATION

Amplitude modulation with transistors is usually a rather messy proposition. Frequency modulation is much more satisfactory, and Amateurs are using f.m. more and more in v.h.f. mobile communications. However, a.m. is widely used commercially in aircraft transmitters and by the military. The aircraft transmitters operate between 108 and 136 MHz., and the military use a.m. between 108 and 152, and between 225 and 400 MHz. For this reason, many transistors have been developed for a.m. use in these frequency ranges. The carrier output of a transistor in a.m. service is very low compared to its c.w. output. For example, the 2N5643 can put out 40 watts on c.w. or f.m. at 175 MHz., but it's only suitable for about 15 watts of a.m. carrier. However, on the modulation peaks, this increases to about 60 watts p.e.p., of course.

In a.m. operation you have to operate a transistor at less than half its collector-emitter breakdown voltage. For example, the 2N5643, which can be used at 28 volts for c.w. operation, cannot be operated at more than about 14 volts in a.m. service; this is because on a.m. peaks the voltage rises to twice the normal maximum, which is already twice the supply voltage. In other words, on a.m. peaks a 13.5-volt supply will give r.f. peaks that rise to 54 volts. A transistor that is to be used in a.m. service at 13.5 volts, then, must have a BV_{CES} greater than 54 volts.

As you can see, an amplitude-modulated transistor has to be operated at about one-half its normal supply voltage, where it provides maximum gain. Its gain will be lower than that of a transistor made specifically for 13.5-volt service. Amplitude modulation involves a number of compromises; it is used only because a.m. equipment is already very popular and widely used. F.m. is far more satisfactory with transistors; it also provides much greater range for the same power inputs.

It might be noted, however, that large aircraft which use a.m. are using transistors—single transistors such as the MM1552 which is suitable for 25 watts carrier output at 135 MHz. with 100 watts peak power. The MM1552 is capable of about 75 watts carrier output in c.w. operation. This particular transistor is used in a.m. service at

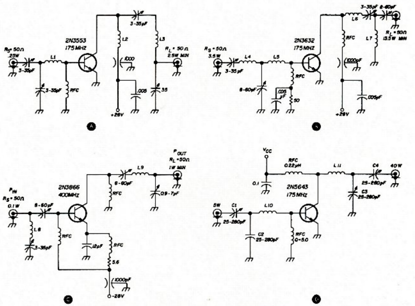


Fig. 4.—Test circuits used for typical r.f. power transistors.

L1, L2—2 turns No. 16 a.w.g., 3/16 in. diam., ¼ in. long.
L3—3 turns No. 16 a.w.g., 3/8 in. diam., 3/8 in. long.
L4, L6—4 turns No. 18 a.w.g., ¼ in. diam., 3/16 in. long.
L5—1 turn No. 16 a.w.g., ¼ in. diam., 3/16 in. long.
L7—2½ turns No. 16 a.w.g., ¼ in. diam., ¼ in. long.
L8—1 in. straight No. 14 wire.
L9—1 turn No. 16, ¼ in. diam.
L10—2 turns No. 18, ¼ in. diam., 1/8 in. long.
L11—2¾ turns No. 18, ¼ in. diam., 3/16 in. long.

† The BV_{CES} is usually numerically about equal to the BV_{CBO}.

13.5 volts, and has a breakdown voltage of about 65 volts.

In a.m. service, because the transistor is operated at relatively low carrier output, it can withstand infinite v.s.w.r. and detuning for a considerable period of time if mounted on an adequate heat sink.

SINGLE SIDEBAND

Single sideband with transistors is still relatively unfamiliar to most users. Transistors have been used for single sideband for some time, particularly by the military, but not too much information is available on this type of operation. A rule of thumb is that a transistor provides fairly low distortion at a peak envelope power output roughly equal to the c.w. r.m.s. output. As an example, the 2N5643, which can put out 40 watts of c.w., can provide 40 watts p.e.p. of sideband with relatively low distortion.

Balanced-emitter transistors are ideal for single sideband because of their excellent linearity. At the present time an inexpensive transistor can provide about 8 to 10 watts p.e.p. s.s.b., making it quite suitable for use alone or to drive an efficient transmitting tetrode tube such as the 4CX1000. This is not enough output, of course, to drive a grounded-grid tube like the popular 3-1000Z.

Table 2 summarises the required voltage ratings of transistors used at 13.5 volts and 28 volts in all popular modes.

READING DATA SHEETS

An important part of using r.f. power transistors is understanding their data sheets. Data sheets on any power transistor or for that matter, any semiconductor, are available from the manufacturer of the device.‡ Most of the data sheet is quite straightforward and though different manufacturers use different formats, similar information is available from most data sheets. One of the first things that you should remember when you are looking at a data sheet is that there are different types of values given. Some are actual maximum ratings. These are the absolute limits to which a transistor should be subjected. Other values are characteristics which describe the actual performance of the transistor.

In the maximum ratings there is no problem about interpreting them; they are quite obvious. However, the characteristics can be **typical** values, or they can be **minimum** or **maximum** values. The manufacturer chooses the value to give him a reasonable yield of saleable devices. At the same time, most of the transistors that he produces exceed the minimum ratings, sometimes by quite a bit. For this reason, typical values are often given on data sheets. These typical values include all of the curves, except one or two such as the safe operating area curve and temperature deratings.

Typical values are very useful in design; however, it is better to design with the minimum values to be on the safe side and insure that your design works properly. The data sheet clearly differentiates between typical and minimum values.

Among the curves which provide typical values are those giving impedances, where it is not practical to give a range. In this case, many transistors are measured, and an average value is put on the curves. These values can vary a bit in individual transistors, but the numbers indicated are usually quite close and satisfactory for circuit design.

One of the first ratings or characteristics that you are concerned about is the breakdown voltage of the transistor as discussed in the section on classes of operation. Many different breakdown voltages are provided on data sheets. The most significant one for r.f. use is the BV_{CES}. If this is not provided, the BV_{CBO} is usually numerically about the same. Half of this value gives you the maximum rating for c.w. or f.m. use; one-quarter of it for a.m. use, as shown in Table 2.

It is interesting to notice the trade-offs that accompany a higher breakdown voltage in a given family of transistors. A higher breakdown voltage indicates a lower output capacitance of C_{OB}. This, of course, can simplify design at high frequencies considerably by reducing the amount of parallel output capacitance. An unfortunate result of higher breakdown voltage is higher d.c. and r.f. saturation voltages.

	13.5v. Supply		28v. Supply	
	BV_{CES}	BV_{CEO}	BV_{CES}	BV_{CEO}
c.w.	30	15	60	30
f.m.	30	15	60	30
a.m. (t'former modulation)	60	30	120	60
a.m. (series modulation)	30	15	60	30
s.s.b. (linear application)	30	15	60	30

Table 2.—Minimum BV_{CES} and BV_{CEO} for transistors used in various modes of operation at 13.5 and 28 volts. Values for a.m. assume 100% modulation.

The reason this is important is that the actual output from a transistor is dependent on the collector voltage swing, or difference between the collector supply voltage and the saturation voltage.

For example, though d.c. saturation voltages are rarely given, for r.f. power devices they typically run around 1.5 to 2 volts for high voltage (28v.) transistors, and a little bit lower for low voltage ones. However, the r.f. saturation voltage is usually about 1.3 times higher and this reduces your power output. As you can see, if you operate a transistor with a high breakdown voltage at a low voltage, you reduce your voltage swing considerably because the high r.f. saturation voltage will remain roughly the same. Thus, a high breakdown voltage results in a lower maximum saturated power output. But as discussed before, a high breakdown voltage is a necessity for amplitude modulation, and so we have to live with the high saturation voltage that accompanies it. This is another good reason to use f.m. rather than a.m.

Incidentally, at high operating voltages, gain is higher than at lower voltages, partly because the higher operating voltage reduces both output and feedback capacitance.

One parameter that is of relatively little importance is the maximum collector current ($I_{C\ MAX}$). Though a safe operating area graph often lists the maximum permissible simultaneous voltage and current for the transistor, these values are usually d.c. or low-frequency ones and are not very relevant at 100 MHz. or so. Transistors aren't often operated near their maximum collector current, anyway, whether they are low-frequency or high-frequency devices.

A vital parameter in a high-power amplifier is the maximum power dissipation. The maximum power dissipation of a transistor is the difference between the input and the output: $P_D = P_{IN\ RF} + P_{IN\ DC} - P_{OUT}$. For example, if you have 1 watt of r.f. input and 10 watts of d.c. input (a total of 11 watts input) and 5 watts output, the dissipation is 11 minus 5, or 6 watts. If you're using a relatively large transistor it may be able to handle this with very little extra heat sinking; however, it is important that sufficient heat sink be provided if necessary.

D.c. current gain or h_{FE}, is relatively important in many applications, but its significance in r.f. power transistors is probably not what you think. A high h_{FE} indicates a high f_T and hence a high power gain at frequencies below the f_T. Nevertheless, high h_{FE} is not desirable in most r.f. power transistors: it results in lower maximum saturated power output, higher intermodulation distortion in single sideband use, greater change in d.c. gain with changing current and, perhaps most important, d.c. and low-frequency instability.

The lower d.c. stability means that it is relatively hard to stabilise the bias of the transistor in class B or AB operation for s.s.b. The a.c. instability can lead to low-frequency oscillation because the transistor has so much gain at these frequencies in comparison with the gain at the very high frequencies at which you want it to operate.

It follows that a high f_T is not necessarily an advantage. The h_{fe} (small-signal a.c. current gain) and f_T are intimately related, since f_T is equal to h_{fe} times the frequency at which h_{fe} is measured. High f_T means higher output resistance in a transistor. Higher resistance can simplify matching requirements in some cases but the high f_T also means a lower input resistance at a given power output. All in all, f_T is not really a very good indication of a transistor's performance in power amplifying service.

The important numbers for you to look for in an r.f. power transistor are its functional tests. R.f. power transistors undergo tests for gain, power output, and in some cases, efficiency, at given frequencies. This is a rather time-consuming, and hence, expensive, operation for the manufacturer and one of the reasons that r.f. power transistors are more expensive than low frequency ones. However, it insures that the transistors are suitable for high-frequency operation.

‡ Data Sheets on any transistors mentioned in the text are available from Technical Information Centre, Motorola Semiconductor Products Inc., Box 20924, Phoenix, Arizona, 85036.

The functional test can be given in a number of different ways; probably the most obvious one is a minimum power output for a given power input at a given frequency. A more common test furnishes the amount of input required for a given output. Power gains are usually given at the same frequency at which the power outputs are measured. Minimum and typical values are often given. The minimum is what you should design with; the typical is what you can hope for.

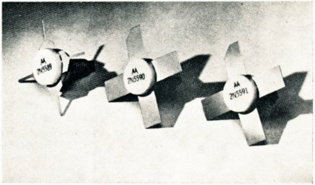
If you do a little bit of figuring, you will find that most power transistors have much lower gain than vacuum tubes you are familiar with. Therefore, more transistors than tubes are required to obtain a given power level in most cases. This is not necessarily true at relatively low frequencies: a power transistor can have very high gain at 50 MHz., for example, if it is designed for use at 400 MHz. Power gain increases about 6 db. per octave, and this can mean that you have much higher gain at lower frequencies.

However, it is not necessarily desirable to use a 400 MHz. transistor at 50 MHz. If you have excessive gain you are likely to have instability. In general, about 15 db. is the maximum gain you should expect to get out of an r.f. power transistor and have it remain stable. More than this and you are likely to be bothered by instability that could be hard to eliminate. In general, you should use r.f. power transistors only in the ranges that are indicated on the data sheet. For example, if output powers and impedances are given for a transistor between 100 MHz. and 400 MHz., you could use it anywhere within that range and probably just a little bit above or below it. However, it would be best not to use this transistor at 30 MHz. or below.

A relatively recent development in r.f. power transistor data sheets is the inclusion of large-signal impedances. Previous to this only small-signal impedances were given: a 20w. transistor might be characterised in a circuit in which it was actually just a low-level amplifier. However, when transistors are operated at high power levels, their characteristics are quite different from those at low power levels.

Table 3 lists the high and low-level impedances for the 2N3948 transistor at 300 MHz. You can see the vast differences between these values. If you use the small-signal impedances to design a transmitter, it won't work properly. Some manufacturers still do not give large-signal impedances, complicating the task of the designer considerably, because he must spend a great deal of time in empirical work. Incidentally, Motorola pioneered in providing large-signal impedances, and they are provided on almost all Motorola r.f. power transistor data sheets.

Three different large-signal impedances are provided: the input capacitance (C_{IN}), input resistance (R_{IN}), and output capacitance (C_{OUT}). The output resistance (R_{OUT}) can be figured from the supply voltage and output power of the specific circuit you are using, and that will be discussed in more detail further along. Incidentally, the output capacitance is roughly twice the low frequency C_{ob} in case this is not given.



New Motorola balanced-emitter transistors in a ceramic strip-line package provide up to 20 watts output at 400 MHz. (2N5637), 40 watts at 175 MHz. with a 28-volt supply (2N5643), or 25 watts at 175 MHz. with a 13.5-volt supply (2N5591). Also available are new transistors that are suitable as drivers for those devices or as lower-power amplifiers.

There are two different ways that impedance data can be presented: in the parallel form, which is given on most Motorola data sheets, or in the series representation. A parallel form would be, for example, 6 ohms resistance in parallel with 30 pF. capacitance. The series form would be the familiar expression using j, such as 25 — j8 ohms. There are advantages to using either form; some networks are easier to design with the series representation, and some with parallel. It is relatively easy to switch from one to another. Later on in the discussion of network design I will indicate when you use the series and when you use the parallel form, and how you change from one to the other.

PACKAGING

The packaging for an r.f. power transistor is vitally important. For large power outputs, specialised packages that provide minimum lead inductance are required. Though the TO-39 package is widely used for low-power transistors such as the 2N3866 and the 2N3553, it is not suitable for powers over a few watts. The next step up is similar to the TO-39 except it provides solid terminals instead of wire leads and uses a stud for mounting (TO-60). Examples are the 2N3375 and 2N3632. These packages are shown in Fig. 5.

A much better package is the strip-line opposed-emitter case, which is used in one form or another by most manufacturers. This type of package provides an isolated stud for mounting. This stud may be mounted directly on a heat sink without insulating washers. Four ribbon leads are provided; two emitter leads, a collector lead and a base lead. The two emitter leads are between the collector and the base leads providing excellent isolation, and the fact that there are two of them makes it easy to provide a very low impedance ground. A wide ribbon is used for high power levels and a smaller one for lower power levels. The Motorola strip-line package is ceramic; some of the others are plastic. The most popular package is only 3/8 inch in diameter, yet can put out over 40 watts of power.

CIRCUIT DESIGN

Amateurs are fortunate in at least one respect when it comes to r.f. power transistors: most Amateur circuits are narrow band, unlike the wideband transmitters required in commercial and military a.m. service. In broadband circuits, considerable gain often has to be sacrificed to obtain the wide band. However, Amateurs can use the transistors in narrow-band service and obtain the performance specified on data sheets without any great problem.

The first problem that a transmitter designer must solve is the frequency at which he will generate his signal, and at what level any frequency multiplication, if that is needed, will be performed. General commercial practice seems to obtain a low-level signal at the output frequency, then perform all the power amplification at this frequency. There are a number of reasons for this: one is that in many commercial applications a frequency synthesizer is used, and its output can conveniently be at the output frequency.

	Class A Small-Signal Amplifier V_{CE} = 15v. d.c. I_C = 80 mA.	Class C Power Amplifier V_{CE} = 13.6v. d.c. P_o = 1 Watt
Input resistance	9 ohms	38 ohms
Input capacitance or inductance	0.012 µF.	21 pF.
Transistor output resistance	199 ohms	92 ohms
Output capacitance	4.6 pF.	5.0 pF.
Power gain	12.4 dB.	8.2 dB.

Table 3.—Small and large-signal performance data for the 2N3948 at 300 MHz. show the inadequacy of using small-signal characterisation data for large-signal amplifier design. Resistance and reactance shown are parallel components. That is, the large-signal input impedance is 38 ohms in parallel with 21 pF., etc.

Another reason is that it is easier to design an amplifier stage than a multiplier. The information required for designing an amplifier can be obtained very readily from a data sheet, while that for designing a multiplier often must be obtained by cut and try. For this reason, it is usually best to plan on having a few milliwatts, say 20 to 100, at the output frequency and amplifying from there. All of the multiplication that is needed can then be done at a low level.

The next problem is whether to use a low-frequency crystal and multiply up, or to use a higher frequency crystal. A low-frequency crystal is usually necessary in f.m. applications where you need to use a relatively low frequency and multiply by a fairly high number to get enough deviation for f.m. However, for a.m. or c.w., it is usually best to use as high a frequency as is practical. Since very little power output is needed, you can use an overtone crystal and just multiply a few times. For instance, for two metre output, a 72 MHz. overtone crystal oscillator can provide a few milliwatts which then can be doubled. This is usually the simplest approach; more important, this high-frequency signal generation reduces the number of harmonics and sub-harmonics that you have to contend with. It is relatively difficult to eliminate frequencies every 8 MHz. across the band, but easy to suppress ones that are 72 MHz. from the desired frequency.

This discussion, of course, has been assuming that you are using crystal control. If you use a variable-frequency oscillator, you'll have some other problems. Then your best bet is to use the heterodyne method so that your v.f.o. operates at a relatively low frequency and beats against a relatively high-frequency crystal oscillator. For single sideband, of course, this is a necessity.

TRANSISTOR SELECTION

Choosing transistors for use in a transmitter can be an interesting task. In many cases, you really have very little choice. You may have a few transistors of a given type, or you may be limited in the amount you can spend for transistors. In this case, your choice will be relatively limited. And considerably simplified, for that matter. In other cases, you will have to decide the power output you want, taking into account the power supply that is available, and work backwards from this. As a practical example, a simple transmitter for two metres will be developed in the rest of this article. This transmitter will also be used to explain simple network design.

Suppose we would like to obtain about 10 watts of c.w. or f.m. on two metres to drive a fixed station amplifier. A 28-volt supply will provide the highest output. A good transistor choice would be the 2N5641. It has a minimum power output of 7 watts at 175 MHz. according to Table 1. Referring to the data sheet, it can be seen that its output at 145 MHz. would be much closer to 10 watts. This transistor costs $US6.40 in single quantity, a reasonable price for a transistor of this output. Table 4 summarises the most important characteristics of this transistor at 145 MHz.; the values were simply taken from the appropriate graphs on the data sheet.

At this frequency, the 2N5641 has an output of 9 watts for an input of 0.5 watt. To be on the safe side, we can use the 2N3866 as a driver. It has an output of 1 watt at 145 MHz. with only 20 milliwatts of input, a gain of about 17 db. This high gain is safe in this low-level stage, and should not cause any problems. A block diagram of the transmitter is shown in Fig. 6.

The 20 mW. of drive can be supplied by a small-signal transistor, such as a plastic-encapsulated MPS3563, an excellent transistor for this use, costing only $US0.44.

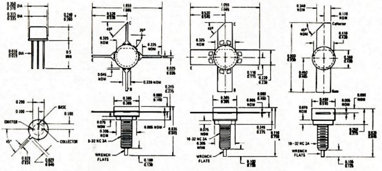


Fig. 5.—Typical packages for r.f. power transistors; from left to right: TO-39, case 144B, case 145A, and case 145C. The 145C case is a ½ inch case; the others are ⅜ inch.

For high power levels, paralleled transistors might be needed. If this is done, some type of equalising network must be provided to insure that both transistors receive the same drive. It is usually very difficult to use push-pull because of the problems in getting balanced drive. However, it should be remembered when considering this that only about 3 db. is gained by using another transistor in parallel. It might be easier to use a larger or better antenna or lower loss lead-in to get this gain in transmitted output.

The transistors discussed in this article generally operate in class C. In usual transistor practice, this means they are operating without any bias except that provided by the signal, without respect to the angle of conduction. Class C amplifiers give excellent efficiency and high power output. They are also self-protecting: if you remove the drive from a class C amplifier, it cuts itself off and does not draw current.

Slightly more gain can be obtained from class A, AB or B amplifiers, but only at the expense of higher dissipation and smaller output. These other classes of operation can provide linear operation: hence they can be used for amplifying s.s.b. or a.m. A class C amplifier can be used only for amplifying c.w. or f.m.

Normally a class C amplifier has a choke or r.f. coil connected directly between the base and emitter (ground), but sometimes a small resistor is connected in series with the base choke. This improves efficiency slightly at the expense of gain and output. This higher efficiency is normally not required except in battery operation or where there might be problems with heat and the higher efficiency would reduce the power dissipation.

Transistor r.f. power amplifiers are usually not neutralised. Neutralisation of a transistor is difficult because its capacitances vary greatly with applied voltages. Almost the only type of neutralisation that is used is emitter tuning. Here a small capacitor is connected from the emitter to ground and tuned for maximum output. A small choke can be placed in the emitter lead, or, at the highest frequencies the emitter lead can provide sufficient inductance by itself.

This emitter tuning can provide higher output and higher power gain, but possibly at the expense of instability. Emitter tuning is a narrow-band tech-

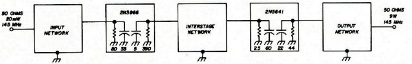


Fig. 6.—Block diagram of a 9-watt transmitter for two metres.

Type	Input	Output	Gain	R_{IN}	C_{IN}	C_{OUT}
2N5641	0.5 W.	9 Watts	12.5 dB.	2.5 ohms*	60 pF.*	22 pF.*
2N3866	20 mW.	1 Watt	17 dB.	80 ohms†	35 pF.†	5 pF.†

* at 7 watts output
† at 1 watt output

Table 4.—Characteristics of 2N5641 and 2N3866 at 145 MHz. and 28 Volts.

nique and not suitable for most commercial use. Amateurs can use it because it is not too difficult to tune up one transistor for maximum power output. However, more conservative design does not accept emitter tuning.

Grounded-emitter operation is almost universal in r.f. power design. The grounded-base configuration is less stable, and adjustments for grounded-base amplifiers are more critical. If neutralisation is required, it is very difficult to implement. Grounded-base amplification might be desirable in some applications, but grounded-emitter stages are usually much more satisfactory. In fact, transistors such as those in the strip-line opposed-emitter package have two emitter leads which are connected directly to ground. These transistors would not be very convenient for grounded-base operation.

In some r.f. power transistors, the emitter is internally grounded to the stud which helps reduce emitter inductance when the chassis is the r.f. ground. However, where the transistor is placed through a hole in a circuit board, the two emitter leads can provide shorter ground paths than an emitter connected to the stud.

MATCHING NETWORKS

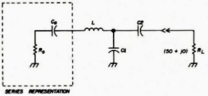
Matching networks are used at the input and output of a power amplifier and between transistor stages. These matching networks serve two functions: impedance transformation and frequency selection. They provide an impedance transformation between the source and input, between the output load and load, and between stages. If a transistor had exactly 50 ohms input impedance or output impedance, the network could be very simple, simply a large capacitor. However, in practice the impedances are usually quite different from 50 ohms. In high-power transistors, the input impedance is often less than 1 ohm, and the output impedance only slightly larger.

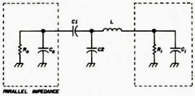
The matching network also discriminates against unwanted frequencies. A simple network usually cannot provide sufficient discrimination, and it is always desirable to use an antenna filter with any type of transmitter that you connect to an antenna.

Transformer or loop coupling is rarely used in transistor r.f. power amplifiers. This type of coupling is hard to adjust for maximum power output and maximum power transfer, particularly at higher frequencies. Instead, simple T networks and L networks are commonly used. Pi networks are rarely used in transistor stages because they often result in impractical component values, such as 0.5 pF. capacitance or 20 nH.§ inductance, whereas other networks give practical values that can be used in a transmitter.

Tuned lines and co-axial cavities provide high efficiencies and frequency discrimination, but they are very bulky at v.h.f. and are rarely used for this reason. In the u.h.f. region, circuits are often built with strip-line techniques. These copper lines deposited on ceramic or high-frequency circuit board give excellent results and are used in many commercial and military applications.

§ The nanohenry, abbreviated nH., is one-thousandth of a microhenry, so 20 nH. equals 0.020 uH.





(A) Input or output matching network.

1. Convert the parallel form of impedance to series form if needed.
2. Select a Q_L (usually 5 to 10; see text).
3. Compute:
   $B = R_o\ (1 + Q_L^2)$
   $A = \sqrt[2]{(B \div R_L) - 1}$
4. Then
   $X_{C2} = AR_L$
   $X_{C1} = B \div (Q_L - A)$

(B) Interstage matching network. This network is useful when Ro is greater than Ri (which is almost always true).

1. Select a Q_L.
2. Compute $A = Ri\ (1 + Q_L^2)$
3. Then $X_L = Q_L\ Ri$.
   $X_{C1} = X_{Co} \sqrt[2]{(A \div Ro) - 1}$
   $X_{C2} = A \div [Q_L - (\sqrt[2]{AR_o \div X_{Co}})]$

Table 5.—Matching networks.

SELECTING Q

An important part of any r.f. network design is choosing the loaded Q. A loaded Q between 4 and 12 provides a good compromise between various considerations. It provides convenient values with most networks, sufficient harmonic attenuation, good efficiency and smooth tuning. The loaded Q, incidentally, is quite different from the unloaded Q of the components. The loaded Q is dependent on the reactance of the components and the output resistance of the transistor. On the other hand, the unloaded Q is determined by the Q of the coils or capacitors and is far higher.

The efficiency of a network depends on the ratio of unloaded Q to loaded Q. Low loaded Q provides easy tuning and high efficiency, but it also provides poor harmonic attenuation. Very high loaded Qs provide excellent attenuation of harmonics but result in critical tuning and high circulating currents which usually result in poor efficiency with practical coils and capacitors. Since an output filter must be considered a necessity in modern operation, the actual value of Q is not critical.

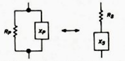
NETWORK DESIGN

The next step is designing the required matching networks. There are a number of approaches to this problem. Perhaps the easiest is using an admittance chart but it is a little involved for this discussion. Another convenient one is the Motorola application note, "Matching Network Designs with Computer Solutions," by Frank Davis.[1] This application note is very easy to use; you simply figure out what kind of network you want to use, which is dependent largely on the values you have to match, and look up the proper values in a table.

I highly recommend that you get a copy of this note if you are going to be doing any transmitter designing. The note includes tables for designing with a number of different types of networks. However, this note is not necessary for circuit design; it can be solved with simple mathematics.

The most commonly used networks are shown in Table 5 with the formulae that are used for solving them. Some of these networks are shown with solutions for a 50-ohm load or source; others are suitable for matching any impedance to any other impedance within certain limitations. Be sure to take note of these limitations: some output networks are only suitable for matching impedances below 50 ohms to 50 ohms; others can be used only for impedances above 50 ohms; still others can be used for matching a wide range of values to 50 ohms.

A point to notice is that some of these networks call for a series representation of the transistor representation. The equations used for converting from series to parallel and from parallel to series are given in Table 6.



(A) To convert a series representation of impedance to a parallel combination of resistance and reactance:
$R_P = R_S\ [1 + (X_S \div R_S)^2]$
$X_P = R_P \div (X_S \div R_S)$

(B) To convert a parallel combination to its series equivalent:
$R_S = R_P \div [1 + (R_P \div X_P)^2]$
$X_S = R_S\ (R_P \div X_P)$

where R_P is the parallel resistance, R_S is the series resistance, X_S is the series reactance, and X_P is the parallel reactance.
$X = 2\pi fL$ for inductance
$X = 1 \div 2\pi fC$ for capacitance

Table 6.—Series-parallel conversion.

Often in a solution of one of these networks the component values that are obtained are not very practical. If this happens another type of network will have to be chosen. In some cases it may be necessary to use two networks in series to obtain a practical impedance transformation.

You may have noticed in Table 4 that the values of the collector resistance for the two transistors were not given. These values are best computed from the power output of the stage and the supply voltage:

$$R_L' = \frac{(V_{cc})^2}{2\ P_o}$$

where R_L' is the output resistance of the transistor, V_{cc} is the supply voltage, and P_o is the power output.

This is an approximation and does not account for the r.f. saturation voltage, but it is accurate enough for design. With this formula it is easy to figure the output resistance of the two transistors: for the 2N3866, $R_L' = 28^2 \div (2 \times 1) = 390$ ohms; for the 2N5641, $R_L' = 28^2 \div (2 \times 9) = 44$ ohms.

The next step is to determine what types of network should be used to match the input to the driver transistors, the driver transistor to the output transistor, and the output transistor to the load.

Referring to Table 5, it appears that the most suitable network to match the output impedance of the 2N5641 to the 50-ohm load is the one shown in Table 5A. The same network is also useful as an input network. Note that to compute this network the transistor output impedance should be in series form rather than the parallel form given on most of the data sheets and in Table 4. Use the equations given in Table 6B to convert from parallel to series representation. Incidentally, the reactances here can be figured most easily from a reactance rule such as the Shure rule, or from a table.

Now let's go through the whole design procedure using the steps listed in Table 5A:—

(1) Convert the parallel form to series (see Table 6B):

$$R_s = \frac{R_P}{1 + (R_P \div X_P)^2}$$

To use this formula we need to find X_P, the reactance of a 22 pF. capacitance at 145 MHz.

$$X_P = \frac{1}{2\ \pi\ f\ C}$$

$$= \frac{1}{2\ \pi\ (145 \times 10^6)\ (22 \times 10^{-12})}$$

$$= 50 \text{ ohms.}$$

This can also be found with a reactance slide rule or table.

Therefore,

$$R_s = \frac{44}{1 + (44 \div 50)^2} = 25 \text{ ohms}$$

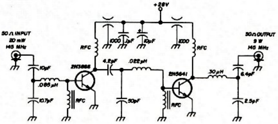
$$X_s = R_s\ (R_P \div X_P)$$

$$= 25\ (44 \div 50)$$

$$= 22 \text{ ohms.}$$

(2) Let $Q_L = 5$. This will provide adequate harmonic attenuation and practical component values.

Fig. 7.—This 9-watt transmitter for 145 MHz. illustrates circuit design. In practice, variable capacitors would be used, of course.



(3) With $R_o = 25$ ohms and $X_{co} = 22$ ohms by step 1, calculate:

$$B = R_o\ (1 + Q_L^2)$$

$$= 25\ (1 + 5^2)$$

$$= 650$$

$$A = \sqrt[2]{(B \div R_L) - 1}$$

$$= \sqrt[2]{(650 \div 50) - 1}$$

$$= 3.5$$

(4) Then,

$$X_L = Q_L R_o + X_c$$

and L = 300 nH. by a reactance chart or by $X \div 2\pi f$

$$= AR_L = (3.5)\ 50 = 175 \text{ ohms}$$

and C_2 = 6.4 pF. (by a reactance chart or rule)

$$X_{C1} = B \div (Q_L - A)$$

$$= 650 \div (5 - 3.5)$$

$$= 430 \text{ ohms}$$

and C_2 = 2.5 pF.

Similar computations are performed for the input and interstage networks. A Q of 5 is also useful here. The complete circuit of the transmitter is shown in Fig. 7.

Once you have determined the proper inductance values for the transmitter coils you must obtain the coils. For low-frequency circuits commercially available inductors can often be used. However, for most v.h.f. use you must wind your own. Most radio handbooks give instructions for this simple operation. Use large wire sizes for lowest losses and be sure to check the inductance with a dip meter and known capacitor.

Other transmitters designed with similar networks are shown in Fig. 8 and Fig. 9. They illustrate the capabilities of modern r.f. power transistors.

AMPLITUDE MODULATION

If you are building an a.m. transmitter the modulation system is quite important. Low level modulation is not recommended because it is inefficient. There are two major methods of high level modulation of an a.m. transmitter, transformer modulation and series modulation. Series modulation requires a supply voltage of twice the voltage required for the transmitter; an audio frequency power transistor in series with the supply to the output stage of the transmitter operates as a variable resistance modulating the transistor output of the transmitter. This method does not use any transformers, but it requires twice the supply voltage that is needed for transformer coupling.

Transformer coupling is more conventional but it is usually difficult to find a suitable modulation transformer. Since relatively high current passes through the windings, a special transformer must be made in cases where the power levels are over a watt or two. You also have to be careful in transformer coupling so you don't apply too much supply voltage to the r.f. power transistor.

It is usually necessary to modulate not only the output stage in a transistor transmitter but also the driver, and in some cases previous stages. This can be done by applying full modulation to the output, partial modulation to the driver, and only upward modulation to the pre-driver, as shown in Fig. 10. The diodes limit the modulation applied to the pre-driver stage to upward modulation.

Modulating all these stages is necessary because the gain of a power transistor is low enough that there is significant feedthrough from earlier stages. For example, a transistor with 10 watts of output may have another watt contributed by the driver stage. If this stage is not modulated it will limit the maximum possible percentage of modulation.

THERMAL DESIGN

An important part of the design of high power transistor transmitters is its thermal aspects, or determining what size heat sink should be used to prevent the device from getting too hot and destroying itself. For relatively low power transmitters this is not a great problem, and connecting the stud to a metal chassis is adequate for powers below about 15 to 20 watts. For higher powered transmitters, more attention should be paid to this topic. Thermal design at r.f. is similar to that

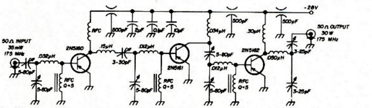


Fig. 8.—30-watt 175 MHz. transmitter uses PNP transistors (from Motorola Application Note AN-481).

at lower frequencies. However, the heat sink must also provide a good path for r.f. in some types of construction. Provision may also have to be made to dissipate considerable extra heat during periods of mismatch or detuning.

PRACTICAL CONSTRUCTION

An important part of building a transistor transmitter, particularly for the v.h.f. range, is using very short leads. The fact that wide ribbon leads are provided for the transistors indicates the importance of this fact. The emitter leads in particular should be as short and direct as possible. An emitter resistor should not be used with balanced-emitter transistors since this is already provided internally. For some other types of transistors where insufficient protection is provided against load mismatch a small emitter resistor may be used. However, this resistor will reduce both power gain and power output.

By-passing is critical in a high power transistor transmitter due to the very low impedances involved. The best approach to by-passing power leads is multiple capacitors. A good technique is to use a feedthrough capacitor with other capacitors in parallel with it. For example, a 1000 pF. feedthrough with a 0.1 μF. disc ceramic capacitor and a 10 μF. electrolytic capacitor in parallel helps assure good by-passing. (But don't use too much capacitance if you are applying audio for modulation).

A good material for the chassis of a transmitter is copper or brass plate, or copper-clad printed circuit board. If printed circuit board is used, be sure that an adequate heat sink is provided for the transistors. With these materials, components can be soldered directly to the chassis, assuring good grounds.

The input of each transistor should be isolated from its output as much as possible; in some cases, a shield may even be necessary where high gains are used.

The chokes used in a transistor transmitter should not have high Q; low Q chokes help avoid many problems. If a high Q choke is used in the base lead, for example, the transistor can take off at lower frequencies. Ferrite-core chokes are excellent in many cases. Ferroxcube VK-200 chokes are often recommended. Another approach is to use a couple of ferrite beads in series with another choke or even in series with just a small resistor or a piece of wire. In most cases, some experimentation is necessary to determine the best kind of choke. It is often a good idea to put a small resistor (10 ohms or so) in parallel with the base choke.

The coils and capacitors that are used in the collector circuit should be suitable for the high circulating currents. Don't forget that in a transistor transmitter currents are often many amperes and even a very small d.c. resistance can cause high losses.

One other problem with any type of v.h.f. equipment, and one that is not well recognised by many Amateurs, is the fact that resistors and capacitors have different values at high frequencies than they do at the frequencies where they are measured. For example, a 100 pF. silver mica capacitor can have a much higher capacitance at 2 metres. Unfortunately, most Amateurs do not have facilities for measuring capacitance accurately at high frequencies.

If you have access to a good v.h.f. bridge or a slotted line you can determine the actual value of a capacitor at the frequency of interest. Lacking this, you may be able to use air variables; their capacitance varies much less than silver mica and ceramic capacitors.

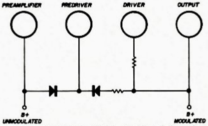


Fig. 10.—Modulation system providing full modulation to the output amplifier, partial modulation to the driver, only upward modulation to the predriver, and constant B plus to the pre-amplifier (from Motorola Application Note AN-481).

In most cases it is possible to avoid resistors in places in the circuit where they are subjected to r.f. This can be accomplished by careful circuit design.

One other important consideration in transmitter construction is the use of a low-pass filter in the antenna lead, or even better, a bandpass filter. This is necessary in vacuum tube transmitters to avoid interference with t.v. sets and other communications. It is even more important in a transistor transmitter where the circuits tend to have lower Q.

ADJUSTMENTS

A few hints for testing a transistor transmitter: rule number one is not to apply any power to a stage unless it is properly loaded. This means a dummy load suitable for the power level you are using. Light bulbs are not satisfactory; a Heathkit Cantenna, lossy coax cable or other good 50-ohm load are.

It is also a good idea to reduce power when you first tune up a transmitter; half voltage is enough. Adjust the tuned stages to approximate resonance if it is practical, since applying drive to a transistor without tuning its output circuit can cause problems. Probably no damage will result, though, if collector voltage is not applied to the transistor. The very low impedance of the base circuit makes it very difficult to develop enough voltage across it to blow out anything.

The usual way to tune a c.w. transmitter is to adjust it for maximum output with a wattmeter or dummy load and field strength meter. A better way is to look at the output on an oscilloscope. This can be done either with a direct connection to the plates of the oscilloscope, or with a mixer that will transform the high output frequency down to a frequency where your scope is usable. The mixer for this application does not need to be very complex. It is sometimes possible to use a receiver in this way if you are sure you are not overloading it.

It is a good idea to listen to the transmitter on your receiver at the output frequency. This will let you hear if any weird oscillation shows up. However, to have realistic results make sure that your receiver is not overloaded. A typical multiconversion v.h.f. receiving system is very susceptible to overloading and all sorts of images. A simple diode detector and amplifier is probably more satisfactory for this application than your high gain, low-noise converter.

Adjusting an amplitude modulated transmitter is more difficult. Here you should tune for maximum upward modulation and least distortion, rather than simply maximum power output. The two rarely correspond. Here again, looking at the signal on a scope and listening to it are imperative.

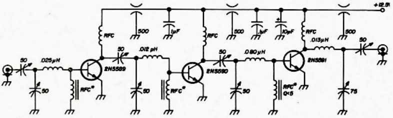
Linear amplification is the most difficult of all. Here you should tune for minimum distortion. A scope is necessary; a spectrum analyser is very useful if you can get one. If you are not careful with a linear amplifier, particularly in single sideband service, you may end up with a very high distortion and many spurious outputs.

In adjusting a transistor transmitter it is a good idea to use a regulated power supply, at least for initial adjustments. Most transistors are very sensitive to changes in supply voltage and you will get inconsistent results if your power supply voltage varies much.

CONCLUSIONS

This article has described the present state of r.f. power transistors and how they can be used in Amateur equipment. It has not gone into great depth in any subject; however, the list of references provide more information on the design and use of r.f. power transistors. Although r.f. power transistors are still relatively expensive, they are practical and should be carefully considered for use in your transmitting equipment.

(Continued on Page 23)



*RFC = FERROXCUBE VK-200 19/4B

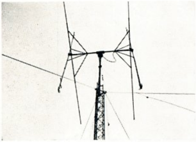
Fig. 9.—25-watt 175 MHz. transmitter designed for a 12.5 volt power supply (from Motorola AN-495).

Construction Details of a Two Element Cubical Quad with One-Loop Triband Elements

HANS F. RUCKERT, VK2AOU*

IT has been shown many times that there is not much difference in performance between a full size three element Yagi 65 feet high and a two element Cubical Quad at the same position. Today most Yagi beams are of more or less shortened triband form (W3DZZ versions), and cannot always be placed as high as 65 feet. It is, therefore, not surprising that in many cases the Quad appears to perform better than Yagis, especially as the Quad does not seem to mind if only 30 feet high, something a Yagi does not like.

My regular DX-sked partners and I still try to find a logical explanation why the one-loop Quad goes so well even on 20 metres, in spite of a 20% shortening of the loop wire, causing a 30% area reduction (a 50% reduction in wind resistance and a substantial weight reduction). The usual triband Quad with its three-wire loops per element seems to be no better than this single loop with 20% shortened wire on 20 metres. On 15 and 10 metres, we can expect more gain due to the extended and nearly doubled wire length respectively. This is not a "mini Quad" on these bands.



VK2AOU's Mono-Loop Triband 2 Element Quad. Boom, cross-arm and support construction on a TR-44 rotor.

THE PRINCIPLE

The original idea goes back to 1958 ("A.R.," May and June, 1958) and background information was published in "A.R.," April 1968, September 1968 and December 1969. Each element consists of two triband dipoles bent at right angles in the middle, where the L-C tuning units are inserted. These dipoles are connected at the ends (sides of loop) to form the Quad loop.

The triband tuning is achieved by placing two parallel tuned circuits in series and also in series with the Quad loop at the upper and lower loop corner. These tuned circuits are not tuned to the Amateur bands or operating frequency of the aerial, and this is in contrast to the method developed by Pichitino and by W3DZZ, where the parallel tuned circuits are traps at the operating frequencies.

In our case the lumped L and C of the tuning components and the distributed L and C of the wire loop combine to give three resonances, which can be placed on Amateur band frequencies like 14.15, 21.3 and 28.6 MHz. The hairpin inductors and the ceramic transmitter type capacitors (double cup types, pieces of RG8U co-axial cable may also be used) are low loss tuned circuits, capable of handling several times the power we can use. The formerly used open wire coils of experimental Quad tuners were replaced by the hairpins to facilitate reproduceability.

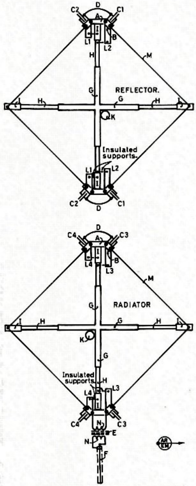


FIG. 1. TRI-BAND CUBICAL QUAD ANTENNA WITH SINGLE WIRE LOOPS.

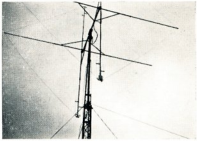
With the main Quad wire disconnected from the tuned circuits we find, with the g.d.o., the following resonances:

L1-C1	....	15.8 MHz.
L3-C3	....	18 "
L2-C2	....	26.9 "
L4-C4	....	31 "

The total wire length of the Quad loop plus the four hairpin loops (per element) are about as long as one wavelength would be, of the longest wave the aerial is to be designed for. The reflector is tuned to 5% lower frequencies to obtain maximum gain. Fine tuning for lowest reverse radiation may be carried out if a small loss in forward gain is acceptable.

TUNING

Satisfactory results can be expected if dimensions shown on the diagram are copied, especially the hairpin lengths to within 2 inches and the capacitors to within 2 pF. If the elements are checked lying horizontally about 5 feet above ground, a 3% lower frequency should be used, to compensate for the change in tuning due to the reduced capacity to ground when the Quad element is later placed upright on the Quad corner. This goes for the six resonances, e.g. three for the radiator and three for the reflector.



VK2AOU's Mono-Loop Triband 2 Element Quad. Hairpin loops (L), enclosed capacitors and ferrite feeder transformer. Radiator at front, reflector is behind.

Fine tuning can be carried out in the following way:

14 MHz.: Quad wire loop length, or L3 (L1 refl.).
21 MHz.: L4 (L2 refl.), or C3 (C1 refl.).
28 MHz.: C4 (C2 refl.).

The radiator is tuned to the operating frequency by checking with the transmitter the frequency which results in the lowest s.w.r. In this way the resonance frequency can be found, regardless of the s.w.r. magnitude. The reflector is tuned to 5% lower frequencies or if desired to give lowest reverse radiation, which can be checked with

* 25 Berrille Road, Beverly Hills, N.S.W., 2209.

a small dipole, GE-diode and milliammeter, placed behind the Quad reflctor (can be quite close).

An s.w.r. of below 1.5:1 should be obtainable on all three bands near the resonance, and a value of 2:1 will most likely not be exceeded at the band ends. An s.w.r. of 1.5:1 is not causing any losses of consequence with 100 feet of RG8U co-axial cable.

BUILDING MATERIAL

Compare with letters shown on the diagram:

A—Bakelite strip 4" x ½" x ¼".

B—Polystyrene 3" x ½" x ¼".

D—Shortening wires, 14 s.w.g. copper. C1 56 pF., C2 26 pF., C3 53 pF., C4 23 pF. Ceramic double cup transmitting capacitors or open ended pieces of RG8U co-axial cable.

E—Q2 Ferrite rod (loop stick type), ½" diam., about 3" long, or Ferrite aerial balun transformer.

F—Co-axial cable, RG8U, any length.

G—Hard aluminium tubing, 12 feet of 7/8" o.d., 1/16" wall.

H—Hard aluminium tubing, 4 feet of ¾" o.d., 1/16" wall. The horizontally placed tube sections of G and H may be insulated with tape from each other at the junction, if they are half wavelength long.

I—PVC tubing ¾" i.d., 10" long (heated up at one end, flattened, cooled and drilled, to hold later the Quad wire, etc.).

K—Boom, 8 feet long, 2" o.d., 1/8" wall, hard aluminium.

L—Total wire length of hairpin loops (before folding up): L1 5' 9", L2 4' 4", L3 4' 9", L4 3' 6". Fold to 2" width, 14 s.w.g. copper wire. 2" of wire may have to be added for connecting and soldering. Check Quad and tuning element resonances with a g.d.o. near the rounded and closed end of the hairpin loops.

M—14 s.w.g. copper wire, 14 feet per Quad loop side (plus wire for connecting and soldering).

N—2 x 9 turns bifilar wound insulated 16 s.w.g. copper wire. 9 turns primary coil goes to the co-axial feeder connector, and the other winding, with also 9 turns, goes between the two tuned circuits at the lower corner of the driven radiator element. The coils are tightly wound on the rod.

ASSEMBLY

The tubing "G" is clamped to the boom with pipe to pipe (U bolts, backing plate, etc.) assemblies.

The hairpin loops are supported by 5" long PVC tubes which are clamped to the cross arms "H".

The ceramic capacitors and the Ferrite transformer are covered by small plastic boxes, which have a breathing hole at the lowest end to help to avoid condensation in the containers.

All wire, loop and capacitor connections are carefully soldered together by first cleaning the wires and pre-tinning each part for an inch length.

Cross arm length: G plus 2 x H plus 2 x I equals 20 feet 2 inches.

If other Quad loop dimensions are desired (2, 6 or 40 metre work), or if for 20, 15 and 10 metres, or other sizes are wanted, one may select Quad loop lengths between ½ and 1¼ of the longest wavelength to be used (for 20 metre, 11 feet to 20 feet). Different hairpin loops and capacitors and different resonance frequencies for the tuning circuits will have to be found.

It is most likely possible to place the tuned circuits at the side corners of the Quad loop and use triple gamma matching of the feeder to the loop at the lower quad corner. (See "QST," Dec. 1969, WA0UDJ's Delta-Loop with VK2AOU tuning method for triband operation. A Delta-Loop is actually a triangular Quad.)

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DEFINITE SUNSPOT NUMBERS FOR 1969

Day	Jan.	Feb.	Mar.	Apr.	May	June
1	68	92	132	156	90	32
2	75	96	111	143	77	47
3	72	98	103	143	70	74
4	98	86	105	122	73	77
5	117	94	108	101	88	116
6	128	101	117	78	71	157
7	146	122	115	82	57	187
8	155	109	108	77	87	190
9	152	102	113	90	81	185
10	150	85	107	85	100	192
11	138	74	101	92	125	195
12	137	64	85	91	149	187
13	124	55	88	122	155	178
14	119	54	90	149	169	166
15	116	70	114	152	146	149
16	116	87	158	144	121	134
17	100	104	170	155	124	105
18	85	101	198	148	117	102
19	73	126	192	128	120	86
20	76	142	196	124	123	97
21	85	169	207	122	163	84
22	105	198	195	90	178	56
23	88	207	157	80	198	43
24	97	215	146	81	205	43
25	103	208	142	81	182	51
26	100	189	149	78	177	28
27	85	171	138	78	145	35
28	79	155	140	72	136	49
29	82		142	68	88	63
30	80		145	72	54	71
31	87		138		50	
Mean	104.4	120.5	135.8	106.8	120.0	106.0

Day	July	Aug.	Sep.	Oct.	Nov.	Dec.
1	125	175	105	99	82	91
2	134	182	94	101	68	107
3	167	177	81	99	83	102
4	160	180	74	99	86	103
5	145	171	71	109	88	95
6	130	153	72	120	98	70
7	123	139	71	123	97	53
8	122	114	67	109	89	43
9	122	108	51	93	94	44
10	120	105	51	85	85	39
11	120	86	67	72	81	28
12	112	70	73	60	76	51
13	98	62	91	57	67	74
14	79	59	95	63	67	94
15	77	62	114	54	68	97
16	75	50	118	47	67	97
17	78	41	123	42	75	99
18	73	35	121	45	86	93
19	66	32	89	50	94	88
20	61	28	65	87	123	96
21	62	39	75	102	127	116
22	60	48	89	113	132	135
23	55	62	91	127	129	122
24	55	68	98	137	119	129
25	53	77	119	141	118	137
26	53	91	127	145	113	131
27	57	104	123	145	109	136
28	79	117	117	131	102	139
29	95	143	107	120	92	152
30	109	138	99	104	90	152
31	137	121		87		122
Mean	96.8	98.0	91.3	95.7	93.5	97.9

Yearly Mean equals 105.5.
Epoch of Sunspot Maximum, 1968.9.
Highest Smoothed Sunspot Number, 111.

—Swiss Federal Observatory, Zurich.

Ross Hull Memorial V.h.f. Contest, 1969-70 Results

TROPHY WINNER

VK3AKC, R. Wilkinson

RESULTS TABLE

(Award Winners in bold type)

Call Sign	48-Hour Score	7-Day Score	Section
VK1ZMR	145	**495**	**B**
VK1VP	130	306	B
VK2ASZ	401	**987**	**B**
AX2ZGX	265	437	B
AX2ZPC	129	253	B
AX2ZTQ	41	88	B
VK2HZ	37	60	B
VK2BDN	560		B
VK2ZRE	200		
VK3AKC	1051	**3338**	**A**
VK3AOT/P3	960	**2250**	**B**
VK3ZKB	482	1310	B
VK3ZYO	217	927	B
VK3AXV	262	758	B
AX3BBB/T		543	B
VK3ZKN	191	312	B
AX3ASV	115	241	B
AX3ZBB	208	127	B
VK3ZHU	**1491**		**B**
AX3ZCK	151		B
VK4ZZE	611	**1858**	**B**
AX4ZRS	357	982	B
VK4ZRS		98	B
VK4ZHS	47	87	B
AX4ZRC	9	20	B
AX5ZNN	150	**350**	**B**
VK5LP	131	302	B
VK6SS		**386**	**B**
VK7WF	330	**1079**	**A**
VK7ZAH	180	361	B
VK7AX	81	116	B
VK7PS	106	108	B
VK9BB/P9		**320**	**B**

Receiving Section

M. Batt, L3312, 675 points (7-days).
S. Ruediger, L5088, 803 points (7-days).

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YL INTERNATIONAL SSBers QSO PARTY

Beginning 0000 GMT, 16th May, through to 2400 GMT, 17th May, 1970. Phone and c.w., in three categories (non-members are as welcome as members).

1, DX/WK teams. 2, YL/OM teams. 3, Single operator. Exchange RST, SSB number (if non-member, name to replace number), State, and Country.

Trophies: 1, world high score, DX/WK teams, each partner. 2, world high score, YL/OM teams, each team. 3, world high score, single operator, combined c.w.-s.s.b.

Plaques: 1, 2nd and 3rd of No. 1 above. 2, 2nd and 3rd, No. 2 above. 3, 1st world high score, single op., s.s.b. only. 4, 1st world high score, single op., c.w. only.

Certificates: 1, 1st, 2nd, 3rd, world high score, each continent. 2, 1st, 2nd, 3rd, each country, state, YL/OM team. 3, 1st, 2nd, 3rd, each country, state, single op. SSBer members and non-members score separately.

Frequencies: Plus or minus 5, 10, 15 KHz. as QRM dictates. Phone 14332, 21373, 28673, 7273 (DX 7090). C.w. 14070, 21070, 28070, 7065.

Logs: Submit to W0GNX, Woody Bennett, 8939 East 31st St., Kansas City, Missouri, 64120, U.S.A., no later than 30th June, 1970. Data to include: GMT date and time, RST sent and received, his state or country, SSBer No., partner's call, bands and modes of operation.

Logs must show six continuous hours of rest in each 24 hours of operation. To qualify for the single operator world high combined trophy, logs must show at least six hours of operation in each mode—c.w. and s.s.b.

For further particulars contact Alf Chandler, VK3LC, 5136 High St., Glen Iris, Vic. Phone 50-2556.

VK-ZL-OCEANIA DX CONTEST, 1970

W.I.A. and N.Z.A.R.T., the National Amateur Radio Associations in Australia and New Zealand, invite world-wide participation in this year's VK-ZL-Oceania DX Contest.

Objects: For the world to contact VK, ZL and Oceania stations and vice versa. **Note**.—VK and ZL stations, irrespective of their locations, do not contact each other for Contest purposes except on 80 and 160 metres.

Dates: Phone—24 hours from 1000 GMT on Saturday, 3rd October, 1970, to 1000 GMT on Sunday, 4th October, 1970.

C.w.—24 hours from 1000 GMT on Saturday, 10th October, 1970, to 1000 GMT on Sunday, 11th October, 1970.

RULES

1. There shall be three main sections to the Contest:
   (a) Transmitting—Phone;
   (b) Transmitting—C.w.;
   (c) Receiving—Phone and C.w. combined.

2. The Contest is open to all licensed Amateur transmitting stations in any part of the world. No prior entry need be made.

Mobile Marine or other non-land based stations are not permitted to enter.

3. All Amateur frequency bands may be used, but no cross-band operation is permitted.

Note.—VK and ZL stations irrespective of their location **do not** contact each other for Contest purposes **except on 80 and 160 metres**, on which bands contacts between VK and ZL stations are encouraged.

4. Phone will be used during the first week-end and c.w. during the second week-end. Stations entering both sections must submit separate logs for each mode.

5. Only one contact per band is permitted with any one station for scoring purposes.

6. Only one licensed Amateur is permitted to operate any one station under the Owner's call sign. Should two or more operate any particular station, each will be considered a competitor, and must submit a separate log under his own call sign. (This is not applicable to overseas competitors.)

7. Entrants must operate within the terms of their licences.

8. **Cyphers**: Before points can be claimed for a contact, serial numbers must be exchanged and acknowledged. The serial number of five or six figures will be made up of the RS (telephony) or RST (telegraphy) report plus three figures which may begin with any number between 001 and 100 for the first contact and which will increase in value by one for each successive contact.

Example: If the number chosen for the first contact is 021, then the second must be 022 followed by 023, 024, etc. After reaching 999, start again from 001.

9. **Scoring**:

(a) **For Oceania Stations other than VK/ZL**: 2 points for each contact on a specific band with VK/ZL stations; 1 point for each contact on a specific band with the rest of the world.

(b) **For the rest of the world other than VK/ZL**: 2 points for each contact on a specific band with VK/ZL stations; 1 point for each contact on a specific band with Oceania stations other than VK/ZL.

(c) **For VK/ZL Stations**: 5 points for each contact on a specific band and, in addition, for each new country worked on that band, bonus points on the following scale will be added:

1st contact	....	50 points
2nd „	....	40 „
3rd „	....	30 „
4th „	....	20 „
5th „	....	10 „

(d) **80 Metre Segment**: For 80 metre contacts between VK and ZL stations, each VK and ZL call area will be considered a "scoring area", with contact points and bonus points to be counted as for DX contacts.

Note.—Contacts between VK and ZL on 80 metres only.

(e) **160 Metre Segment**: For 160 metres, contacts between VK/ZL, VK/VK, ZL/ZL and VK/ZL to the rest of the world: Each VK/ZL call area will be considered a "scoring area" with contact points and bonus points to be counted as for DX contacts [Rule 9(c)].

Note.—A contestant in a call area may claim points for contacts in the same call area for this 160 metre segment.

For this purpose the A.R.R.L. Countries List will be used with the exception that each call area of W/K, JA and UA will count as "countries" for scoring purposes as indicated above.

10. **Logs**: (i.) **Overseas Stations**—

(a) Logs to show in this order: Date, time in GMT, call sign of station contacted, band, serial number sent, serial number received, points. Underline each new VK/ZL call area contacted. A separate log for each band must be submitted.

(b) **Summary Sheet** to show the call sign, name and address (block letters), details of station, and, for each band, QSO points for that band, VK/ZL call areas worked on that band.

"All-band" score will be total QSO points multiplied by sum of VK/ZL call areas on all bands, while "single-band" scores will be that band QSO points multiplied by VK/ZL call areas worked on that band.

(ii.) **VK/ZL Stations**—

(a) Logs must show in this order: Date, time in GMT, call sign of station worked, band. serial number sent, serial number received, contact points, bonus points. Use a separate log for each band.

(b) **Summary** to show: Name and address in block letters, call sign, score for each band by adding contact and bonus points for that band, and "all-band" score by adding the band scores together; details of station and power declaration that all rules and regulations have been observed.

11. The right is reserved to disqualify any entrant who, during the Contest, has not strictly observed regulations or who has consistently departed from the accepted code of operating ethics.

12. The ruling of Federal Contest Manager, W.I.A., will be final.

13. **Awards**:

VK/ZL Stations: W.I.A. will award certificates as follows:—

(1) To the top scorer on each band irrespective of single-band or multi-band operation and irrespective of call area, i.e. maximum of one award may be made for VK **and** ZL, for each band.

(2) To the top scorer in each VK and ZL call district, i.e. a maximum of 15 awards, 10 VK and 5 ZL awards may be made.

To be eligible for awards in either of the above mentioned categories, an operator must obtain at least 1,000 points or there must be at least three competing entries in the category.

Overseas Stations: Certificates will be awarded to each country (call area in W/K, JA and UA) on the following basis:

(1) Top scorer using "all-bands" provided that at least three entries are received from the "country" or the contestant has scored 500 points or more.

(2) Other certificates may be awarded, to be determined by conditions and activity.

N.B.—There are separate awards for c.w. and phone.

14. **Entries**: All entries should be posted to Federal Contest Manager, W.I.A., Box N1002, G.P.O., Perth, Western Australia, 6001, **or** N. Penfold, 388 Huntriss Road, Woodlands, Western Australia, 6018.

VK/ZL entries to be **received** by 31st December, 1970. Overseas entries to be **received** by 22nd January, 1971.

RECEIVING SECTION

1. The rules are the same as for the transmitting section, but no active transmitting station is permitted to enter this section.

2. The contest times and logging of stations on each band per week-end are as for that transmitting section except that the same station may be logged twice on any one band—once on phone and once on c.w.

3. To count for points, logs will take the same form as for transmitting, as follows: Date, time in GMT, call of station heard, call of the station he is working, RS(T) of the station heard, serial number sent by the station heard, band, points claimed. Scoring is on the same basis as for transmitting section and the summary should be similarly set out with the addition of the name of the S.w.l. Society in which membership is held if a member.

4. Overseas Stations may log only VK/ZL stations but VK receiving stations may log overseas stations and ZL stations, while ZL receiving stations may log overseas stations and VK stations.

5. Certificates will be awarded to the top scorer in each overseas scoring area and in each VK/ZL call area provided that at least three entries are received from that area or that the contestant has scored 500 points or more.

SLOW SCAN T.V. PERMITTED

Following requests made to the Radio Branch, Postmaster-General's Department, the Wireless Institute, through Federal Executive, have been advised that slow scan t.v. (also known as narrow band t.v.) is now approved for use on all Amateur bands.

Identification must be made by call sign in visual form on the televised picture and by telegraphy when a telephony sound channel is also used.

For those unfamiliar with the techniques, a list of references is given at the end of this announcement for technical details.

In brief, slow scan t.v. is a system of picture transmission with a bandwidth not in excess of that occupied by an amplitude modulation single sideband voice transmission, and can permit simultaneous voice transmission provided the total bandwidth occupied does not exceed the bandwidth of a normal double sideband (voice) amplitude modulated transmission.

The necessary bandwidths for single and double sideband are considered to be 3 KHz. and 6 KHz. respectively.

Standards.—Amateurs are free to use any standards within the bandwidths listed, and as some U.S.A. operators have done extensive work, the following figures are given for guidance, especially if DX work is contemplated:

- Sweep rates, 15 c.p.s. (60 c.p.s./1).
- Vertical, 1/8 c.p.s.
- Scanning lines, 120.
- Aspect ratio, 1:1.
- Scan director, left to right.
- Vertical, top to bottom.
- Sync. pulse duration:
  - Horizontal, 5 milliseconds.
  - Vertical, 30 milliseconds.
- Sub-carrier frequencies:
  - Sync., 1200 c.p.s.
  - Black, 1500 c.p.s.
  - White, 2300 c.p.s.
- Required transmission bandwidth, 1.0 to 2.5 KHz.

Slow scan t.v. is transmitted by frequency modulating a sub-carrier between the limits of 1500 c.p.s. (black) and 2300 c.p.s. (white). Vertical and horizontal synchronisation is maintained by transmitting short bursts of 1200 c.p.s. tone. Live scenes are transmitted as a series of "stills".

The output signal from the scanner is introduced into the audio section of the s.s.b. transmitter and is transmitted without a loss of picture detail in the conventional s.s.b.s.c. transmitter voice bandwidth.

In conclusion then:

(1) Slow scan t.v. is allowed on all available Amateur frequency bands, subject to identification requirements listed earlier.

(2) Single sideband or double sideband A5 emissions may be used and the bandwidth shall not exceed that of an A3 single sideband or double sideband signal respectively.

(3) Where A3 or A5 emissions are used, simultaneously on the same carrier frequency the total bandwidth shall not exceed that of an A3 double sideband emission.

(4) Standards within the bandwidth limits are at the discretion of the Amateur. However, those used by U.S. operators have been listed above, and serve as a guide.

REFERENCES

Articles giving theory and practical information are as follows:

"CQ" July, August, 1969, "Slow Scan T.V.," by Don C. Miller, W9NTP.

"QST" August, September, 1958, p. 31, C. McDonald, "Narrow Band Image Transmission System".

"QST" March, 1969, p. 45, C. McDonald, "Slow Scan Monitor".

"QST" September, 1966, p. 38, C. McDonald, "Twenty Metre Slow Scan T.V. Tests".

"QST" June, July, August, 1965, "Vidicon Slow Scan Camera".

"73" October, 1967, "Slow Scan Picture Converter".

"73" July 1967, "Slow Scan Monitor".

REPEATERS

In answer to a request for clarification on repeater operation, the Controller, Radio, P.M.G. Department, has provided the following information which, where conditions for such operation are met, will allow repeaters to be established.

Reference should be made to October 1968 "A.R." which carried the requirements for repeater operation.

The additional points are as follows:

(1) Licences for u.h.f. repeater translators may be issued to responsible groups such as the W.I.A.

(2) The group will be required to nominate a suitably qualified person or persons willing to accept the responsibility for the operation of the station.

(3) All repeaters must incorporate facilities for the automatic identification of all emissions.

Discussion with the Controller has indicated that identification can be made using c.w., and in the case of an Institute sponsored repeater, the call sign VK2AWI/R1, for example, would be acceptable. This would not however preclude the use of VK2AWI for other Amateur activities. If more than one repeater is established by any Division, the same call with the suffix R2, R3, etc., can be employed.

It is important that the transmissions from repeaters be readily identifiable in the event of interference or other malfunction, hence the necessity for some form of identification.

Applications for repeaters should, ideally be co-ordinated within a Division and requests and/or proposals should be made through Divisional repeater committees. The responsibility for Australia-wide co-ordination is in the hands of the Federal Repeater Secretariat.

STANDARDS ASSOCIATION OF AUSTRALIA

We have arranged with the Standards Association of Australia to reprint items from their monthly information sheet which may be of interest to our readers. At the same time, we arranged that we receive copies of any press releases which may be of interest.

The Standards Association welcomed our approach and expressed the opinion that through the medium of "Amateur Radio," they would reach a number of people interested in standards in the electronic field, who otherwise would not be aware of the work being done in this field.

The Standards Association of Australia offices are located at the following addresses:—

N.S.W.: 80 Arthur Street, North Sydney, 2060. Phone 929-6022. Also at 14 Watt Street, Newcastle, 2300. Phone 2-2477.

Vic.: 191 Royal Parade, Parkville, 3052. Phone 34-9321.

Qld.: 447 Upper Edward Street, Brisbane, 4000. Phone 2-8815.

S.A.: 11 Bagot Street, North Adelaide, 5006. Phone 67-1757.

W.A.: 10 Hooper Street, West Perth, 6005. Phone 21-7763.

Tas.: 18 Elizabeth Street, Hobart, 7000. Phone 34-5412.

NEW DRAFT STANDARD

1526—The Reliability of Electronic Equipment and Components. Part II.—Reliability Concepts

This draft forms one part of a comprehensive standard on the reliability of electronic equipment and components. This part is intended to provide guidance to manufacturers and purchasers alike, on the basic concepts inherent in the establishment of reliability of equipment or component parts. Although written in particular for the field of electronics, it will obviously have a much wider application. Latest date for comment is 30th June, 1970.

NEW WORK STARTED

Radio Interference Measuring Apparatus

Work has commenced on the preparation of a standard for radio interference measuring apparatus for the frequency range 0.015 MHz. to 1000 MHz., covering quasi-peak, peak and sine wave measuring instruments. BS727 is being used as the basis for committee drafting.

Symbols for Semiconductor Devices

As part of work on graphical symbols of electronic components, consideration is being given to the preparation of standard symbols for semiconductor devices. The work of I.E.C. is being taken into account.

AMATEUR FREQUENCIES:

USE THEM OR LOSE THEM!

S.A.A. COMMITTEE ACTIVITIES

Radio Interference
(Committee No. TE/3)

This committee met recently in Sydney, immediately preceding a symposium on radio interference held at the University of New South Wales. Members agreed that a draft Australian standard be circulated for public review, based on BS727, and specifying quasi-peak and sine wave measuring instruments. The instruments to be used in the measurement of particular types of interference will then be specified in the relevant standard. There was some discussion of future work and members agreed that this be concentrated on setting limits of interference with priority being given to radio and t.v. reception, and the revision of AS C321-1959.

Semiconductors
(Committee No. TE/12)

This committee met in Adelaide in February. It completed an initial review of work that had been in abeyance when the committee had been reconstituted, including revision of Docs. 1054, 1012, 1013, 1014, 1015, 1122 and 1123. Three of these drafts have now passed the stage of postal ballot and will be published, while the other drafts have yet to go to postal ballot. The committee expects that this group of standards will provide a comprehensive basic set for semiconductor devices covering such aspects as terminology, dimensions, basic parameters and physical properties to be measured and catalogued.

Graphical Symbols
(Committee No. TE/13)

This committee is continuing its preparation of a range of graphical symbols for use primarily in the electronics industry. Comment received on Doc. 1461, Letter Symbols to be Used in Electrical Technology, has been examined and a new draft, incorporating minor amendments is to proceed to postal ballot. A draft standard for semiconductor devices, compatible with I.E.C. Recommendations in this field was examined and is to be submitted for public review.

Radio Communication
(Committee No. TE/14)

This committee met recently in Sydney and has formed three sub-committees to handle various aspects of the programme of work agreed at the first meeting. One sub-committee is to deal with radio and t.v. reception, another with radio and t.v. transmission, and the third with radio and t.v. aerials. This last task will include a revision of AS CC8-1962, Construction and Installation of Radio and T.V. Receiving Aerials.

The committee asked that the work of this committee be made widely known and that all interested bodies be requested to indicate those aspects of radio communication in relation to which standardisation is considered feasible.

R.F. POWER TRANSISTORS

(Continued from Page 18)

REFERENCES

1. Frank Davis, "Matching Network Designs with Computer Solutions," Motorola Application Note AN-267, Motorola Semiconductor Products, Inc., Box 20924, Phoenix, Arizona, 85036.
2. Roy Hejhall, "Systemising R.F. Power Amplifier Design," Motorola Application Note AN-282, Motorola Semiconductor Products, Inc., Box 20924, Phoenix, Arizona, 85036.
3. R.C.A. Silicon Power Circuits Manual, Radio Corporation of America, Electronic Components and Devices, Harrison, New Jersey.
4. John G. Tatum, "V.H.F./U.H.F. Power Transistor Amplifier Design," Application Note AN-1-1, I.T.T. Semiconductors, 3301 Electronics Way, West Palm Beach, Florida, 33407.
5. Frank Davis, "A 30-Watt 175 MHz. Power Amplifier using PNP Transistors," Motorola Application Note AN-477.
6. Dick Brubaker, "A broadband 4-Watt Aircraft Transmitter," Motorola Application Note AN-481.
7. Roy Hejhall, "A 25-Watt 175 MHz. Transmitter for 12.5 Volt Operation," Motorola Application Note AN-503.
8. Dick Brubaker, "A 13-Watt A.M. Aircraft Transmitter," Motorola Application Note AN-507.

☆

ELNA LITERATURE

A four-page leaflet on Elna electrolytic capacitors featuring the new stock range for 1970 is now available from Soanar Electronics Pty. Ltd.

The leaflet contains full details of both physical and electrical characteristics of the Elna range, with a list of Australian distributors.

In addition, there are brochures available to readers on "Greencap" and "Ceramic" capacitors, from Soanar head office at 30 Lexton Rd., Box Hill, Vic., or from their interstate representatives.

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TRANSISTOR TEST SUPPLY

Latest addition to the range of test equipment at Radio Parts Pty. Ltd. is a new transistor test supply which is illustrated on the back cover of this month's "A.R." This low priced unit will meet the needs of many Amateurs involved in solid state circuitry; further details may be obtained from the instrument department of Radio Parts Pty. Ltd., 562 Spencer St., Melbourne, Vic.

☆

AWARDS

Monitor Award.—This is the first award made available by the I.S.W.L. to non-members, cost is five shillings sterling, claim forms can be obtained from Cliff Tooke, 6 Chelmer Ave., Rayleigh, Essex, England. The award is available to any Amateur or S.w.l. who qualify by having proof of contact or hearing 25 league members. Stickers are provided for each additional 25 members, and endorsements are available for any band or mode. I have given you the calls of the DX and some W members in the QSL section, and will complete this next month. Any 25 of those listed will qualify for the award and most of these chaps will identify themselves in QSO. Stations on the list will be valid until 31st Dec. this year, when a new list will be published.

5N1 Award.—This one is a very fine award according to Ernie Luff (76 years young on Good Friday), and to qualify you need to hear or contact HK3AFB, VK, RQ, AJV, HC and UA. QSLs not required, but these six stations must have your QSL before you claim. No cost, send to custodian, HK3AFB, Box 11392, Bogota 2, Colombia, South America.

VHF

Sub-Editor: ERIC JAMIESON, VK5LP
Forreston, South Australia, 5233.

AMATEUR-BAND BEACONS

VK4	144.390	VK4VV, 107m. W. of Brisbane.
VK5	53.000	VK5VF, Mount Lofty.
	144.800	VK5VF, Mount Lofty.
VK6	52.006	VK6VF, Tuart Hill.
	52.900	VK6TS, Carnarvon.
	144.500	VK6VE, Mount Barker (Albany).
	145.000	VK6VF, Tuart Hill.
	435.000	VK6VF (on by arrangement).
VK7	144.900	VK7VF, Devonport.
ZL3	145.000	ZL3VHF, Christchurch.
JA	51.995	JA1IGY, Japan.

No comments have come to hand re the listing of beacons last month, so can only assume no corrections are needed. The list is repeated above. Following my recent comments on lack of beacons in VK2, I have received a letter from Tim VK2ZTM, who is Chairman of the Federal Repeater Secretariat, and I take the liberty of quoting:

"There are plans in hand to include beacon or similar type transmitters in the equipment re-build of the Divisional Station VK2WI at Dural. It is planned to have 6 and 2 metre units as straight beacons which will double as stand-by transmitters for broadcast purposes. On 432 and 1296 MHz. the beacons will also serve as the main broadcast transmitters. On the v.h.f. side of the re-build the additional equipment to be installed will be a.m. and f.m. net gear on 6; a.m. tunable repeater and f.m. net on 2 metres. On 432 MHz. there will be a t.v. transmitter to which one can bring a camera. This, together with link and other equipment to our Atchison St. system and h.f. transmitters on 160, 80 and 40 metres, will make the re-build a major effort."

This is very welcome news, and when completed will fill a long standing gap. I am sure I voice the thoughts of the VK v.h.f. fraternity when I say good luck with all your efforts VK2, but make the 2 metre beacon top priority! Now VK3, what are you doing in this field? There have been rumours of a beacon on 2 metres but that's about all. And VK1, any thoughts you may give to a beacon on 2 metres at least will be very welcome news, you are beautifully situated distance-wise to Adelaide, Melbourne and Brisbane, so what about it? Once we have some beacons running in all States, that will be one platform I can take down!

Thanks to Ron VK7ZRO, of Howrah, near Hobart, for some interesting news while operating portable (that's the boy!) from Mt. Wellington (4,166 feet) on 15th March. On 2 metres Ron worked Col AX5CJ and AX5ZKR, both in Mt. Gambier, signals to the latter being S9 both ways. Also worked were AX-3ZPA, AX3ZKN, AX3ZDW and AX3ZBB. Ten other stations heard. An interesting feature of these contacts was that Ron used all solid state equipment, the transmitter having a 2N3866 in the final running with an output of less than 1 watt!!! Antenna, 5 element Yagi. 432 MHz. was also tried with success. Using a QQE02/6 in the final running 9 watts input, Ron was able to make two-way communication with Colin AX5ZKR in Mt. Gambier with reports of 5 and 5. On first calculations, this looks to be a distance of about 470 miles, which if correct will easily eclipse the former record held by Mick VK5ZDR and Ian VK3ALZ of 405 miles. Peter AX3ZPA also came to the 432 party and he and Ron exchanged signals S9 and S8 both ways. So, it just goes to show what the combination of good conditions and location will achieve, and we hope this will not be Ron's only exploit in this field.

A brief message from Lance VK4ZAZ came when he dropped an S9 signal into VK5 on 8th March, reporting that JAs have been available at his location regularly each day since 5th February, and working mainly northern VK4. and not extending further south than Brisbane, and across to VK6FR in Broome. So it seems that until this continent of ours is washed a thousand miles further north those in southern VK will have to be content with listening to the exploits of our northern neighbours. I note with interest in the April listing of 52 MHz. W.A.S. Award that Lance has added a further additional country to his list which now stands at 9. A very fine effort.

Due to postal holdup, a letter arrived too late from Eddie VK1VP with some details of National Field Day operation when he joined with VK1ACA (The Canberra Radio Society) for portable operation. Best contact was first time into Melbourne on 2 metres to Geoff VK3AMK. Only contact on 432 MHz. was to VK2AAK. Nothing heard from VK5 on v.h.f. Small wonder, see last issue's V.h.f. Notes for details of weather conditions!!

Eddie raises an issue and I would like to hear from readers on it so your thoughts can be passed on to the appropriate people. This refers to the proposed "Worked All-Bands" Award which was approved in principle at the 1969 Federal Convention. Do you think that a section which could be devoted to v.h.f. and higher bands should be limited to "Z" or "Y" calls only? There are some Amateurs you know who work only on v.h.f. by choice. Should they be excluded? For the purposes of the award, the 432 and 576 MHz. bands may be lumped together. Do you think this is a good idea? Sure, 576 is a temporary allocation, but it may be a long time before it is needed for something else. In the meantime, should it receive separate recognition? The award cannot satisfy everyone, particularly on v.h.f., but do you think there should be one nevertheless? Your early comments would be appreciated.

I note the South East Radio Group in Mt. Gambier is hard at work on preparations for their forthcoming Convention during the June holiday week-end, 13th and 14th. Such news comes from "The Critter of the Crater", or more conventionally, David VK5ZOO. Some very "sneaky" hidden transmitter hunts are planned, "cunning" fox hunts, and if you want to see your XYLs speechless for once, let them join in the YL scramble! There's always a barbeque on the Saturday night, followed by a jumble sale and guest speaker, and most of those present really fast themselves in readiness for the tremendous spread served by the S.E.R.G. ladies on the Sunday night—real country-style food and stacks of it! The S.E.R.G. boys will assist you by booking accommodation, but you should get in early. Further information from Colin VK5ZKR.

There should be more c.w. on the v.h.f. bands in the near future if the six students of Kevin VK5OA all pass the exam. These are the various Limited licensees in Mt. Gambier making a joint effort to broaden their interests. As long as we don't lose them from v.h.f., the rest of us approve of their action!

I am pleased to be able to number amongst my "fans" one Samson Voron, an S.w.l. of Coogee, N.S.W., who is President of the Randwick Boys' High S.w.l. and Amateur Radio Club. Samson sent me a very good photograph of his reception of Channel 1 in Port Pirie, S.A., and also extensive details of reception of sound and video from many Australian t.v. stations, plus quite a few from New Zealand including the low power translators, all received on a standard t.v. set with under-roof antenna. He is also a keen 6 metre listener and mentions quite a few call signs monitored. I hope the Radio Club will continue to be a success and from it will come further Amateurs to add to our ranks.

Did many of you tumble to the fact that the cause of excessive noise on the v.h.f. bands on Sunday, 29th March, around 1000 hours was due to a solar flare? H.f. reception was blanketed out for some time, which is the normal pattern of events for these disturbances.

FROM THE PAST

Everyone seems to be jumping on this bandwagon during this year of celebrations. However, the following observed in "QST" of 30 years ago. "U.h.f. DX Records, two-way work. 56 Mc.: W1EYM-W6DNS, July 22, 1938, 2,500 miles. 112 Mc.: W9WYX/9-W9VTK/9, October 7, 1939, 160 miles. 224 Mc.: W1AIY-W1KLJ, April 27, 1940, 6 miles." A further claim of 200 miles on 112 Mc. was being considered. Distances have grown a lot since those days of course, when equipment was largely super-regenerative.

News from interstate is scarce this month, so why waste space for the sake of talking, so the notes will finish now. The thought for the month: "Life is like an onion; you peel it off one layer at a time, and sometimes you weep." Until next month, 73, Eric VK5LP, "The Voice in the Hills".

MEET THE OTHER MAN

In an effort to keep this segment alive I am forced this month to seek help from another VK5 due to non return of requested information from interstate participants. It appears necessary now to have the prepared pro forma requesting information in the hands of five or six simultaneously in the hope that some will come to the party in time for each issue. The risk of stale information is thereby increased, but there seems no other way.

John Hackworth, VK5QZ (formerly VK-5ZJH), lives at 34 Oaklands Road, Somerton Park, 7 miles south-west of Adelaide, not very far above sea level, which is about 1½ miles away. First licensed in 1961, John has certainly since then made his presence felt in v.h.f. and u.h.f. matters, and now has equipment on 52, 144, 432, 576 and 1296 MHz. He operates mainly on s.s.b. on 52 and 144 MHz., but can be heard occasionally with re-inserted carrier a.m. 100 watts p.e.p. on both bands ensures a nice signal, one which is probably as easy to resolve as any I have heard. Both bands use a QQE06/40 in the final, 6 metres to a 4 element Yagi 20 feet high; 2 metres, 10 element Yagi 35 feet high. Transistor converters are used for reception into various home-brew tuneable i.f. systems.

John operates about 30 watts input of a.m. on 432 from a QQE03/20 to a 16 element phased array up 38 feet, with a 5QZ special FET converter. The 432 equipment, as well as 576, is orientated towards portable operation, and full use is made of transistors wherever possible to keep down current drain. The 576 MHz. equipment is very similar to 432, with another 3/20, modified 5QZ converter, and 32 element extended array. The 1296 equipment so far is limited to transmitting, the 432 MHz. gear is coupled to a MA4060 varactor diode tripler to give about 1 watt out. The antenna at present is an 8/8 skeleton slot.

For call areas worked, John has to his credit on 52: VKs 1 to 9 inclusive, and ZL1, 2 and 3. On 144: VK3, 5 and 6; and 432: VK3 and 5. Probably one of his more favoured bands is 576 MHz., where with the help of Treva VK5ZIS he now holds the Australian record set on 28/12/69 with a two-way contact with Graham VK5ZJL over a distance of almost 200 miles. John has no immediate plans to extend this range, but will be prepared to do so if challenged for the record by anyone else!

John is a member of the W.I.A. and is Secretary of the VK5 V.h.f. Group, a task which he carries out well. A dedicated v.h.f. man, he has so far shown almost no interest in h.f. operation, and his future plans revolve around becoming fully operational on 1296 and probably higher frequency bands; increasing his ability to operate portable by the greater use of transistors and associated devices.

There are probably a couple of things by which John will be remembered, most importantly, the 5QZ 432 MHz. converter. This was designed originally by John, and having proved its worth, was adopted by the VK5 V.h.f. Group as a project. Many kitsets have already been sold and are operating satisfactorily. The design is attractive because it is simple, easy to construct, and most important, it really works. The converter lends itself very readily to conversion to 576 MHz. with equally good results, so it is a very versatile instrument. The other point we can remember about John is his ability to design equipment, improvise where necessary, and sometimes produce the most outlandish looking piece of gear which actually works. Ask anyone about the FET voltmeter he brought to a v.h.f. members' equipment night, just thrown together and carried in a shoe box—and it worked!

Finally, John is very keen on portable operation and in this I have found a firm friend. We have been out together several times and I look forward to many more occasions, hoping for the day when we may "crack the oyster" and shift one of the existing records up some more miles in the u.h.f. region.

John's photograph appeared in March "Amateur Radio" with his 576 MHz. antenna. He has declined appearing again so soon.

DX

Sub-Editor: DON GRANTLEY
P.O. Box 222, Penrith, N.S.W., 2750
(All times in GMT)

Every band has its own special enthusiasts and none are more keen than those of our number who specialise on ten metres, regardless of whether they are licensed Amateurs or listeners. Thus, when this band finally burst into life late in March, there was much rejoicing. On 21st March at 2058z, Maurie Cox in Melbourne logged signals ranging from KX6, KH6, ZL to W6, W0 and across the States to W1 and W2. At 2130z the Ws from the East coast were pounding in, and at 0514 that afternoon, the band was still wide open to 9J2, ZS, JA and ZL. To show that this was no fluke, at 0515 on 23rd March, much the same conditions were prevailing. Over the Easter weekend, Mac Hilliard in a Sydney suburb noted an exceptionally good opening with 9J2, ZE2, OD5, ZS5, SM7 and SM6 being to the fore. Concentrating on the c.w. segment over Easter, I noticed quite a lot of strong signals from the Russians, also W4, however my receiver is virtually useless on 10 metres. How long these conditions will hold up is anybody's guess, and maybe by the time this issue of "A.R." reaches you the band will be flat again. But how about some VK activity up there? Maybe there are quite a few chaps working this frequency and are not audible here. Whatever the situation it would be very pleasing to the overseas stations who called CQ madly over Easter to have a welcome reply from VK.

To summarise band conditions in general, 15 metres is still very good from early morning to quite late in the day, 20 metres provides most of the really good DX, with some good signals coming in on 40, and reports of W2s on 80 s.s.b.

Jack VK3AXQ, writing from Tatura in Vic., has worked some excellent DX on 20 using a FT-DX-100 with a 20 metre dipole up only 12 feet. Using both modes, Jack hooked EA4, 9N1, WB2, AX9, ZS5, PJ2, 1R0, DL3, HB9, 9M2, KW6, FB8YY, OK3, YV, EA1, CE8, GI3, VS6, AX0, EA9, VU, VR2, 4S7, G6, HR1, CT1, OH2, UG6, CT2 and about twenty more.

BY1PK still continues from China, often on 14028 c.w. at around 0100z. His QSL address is Box 427, Peking, Peoples Republic of China. I list this in response to several queries about it, but I hasten to say that you will be swamped with all the propaganda they ever wrote.

Activity from the Isle of Man is reported from GD3GMK who says QSL via Jeff GW-3NWV, also GD5APJ has been logged quite regularly at this QTH on 20 c.w.

JW7UH has been bringing down some dog-piles on 20 of late, and is also reported on 21322 at around 1500z. His QSL address is Erling Oyan, N-9173, NY-Aaleshund, Svalbard, Norway.

American K prefixes in the Pacific to be heard and worked at the moment are KC6RS and KC6CW from East Carolines, KJ6CF and KJ6BZ from Johnston Is., KS4AZ on 14057 from Swan Is., W9FIU/KS4 was on from Serranna Bank, whilst KG4DS has been providing some action from Guantanamo Bay in Cuba on 28519 at around 2100z, saying QSL to VE3BYN.

SU1MA is reported from several parts of the world as being regularly active on 14230 at around 0400z. His QSL address is Box 840, Cairo, Egypt.

Two interesting stations showed up on 28th Feb. for 24 hours. They were 5H3LV/A and 5H3KJ/A, the former on 20 metres, QSL to VE3ODX, the latter on 15, QSL to W7VRO. They were operating from Latham Is., the smallest of the Zanzibar group.

YI2AB from Iraq is worth a glance. Although he is rare, there is no dogpile on him, and you may find him on 7 MHz. at midnight GMT (little hope here), 14 MHz. at 1700, 21 MHz. at 1400z, 28 MHz. at 0900z, 3.5 MHz. at 0500z, and he will try 1.6 at 2045z, but if nothing doing there will QSY to 14 MHz.

We have had at last some activity from JY, SV0WI/JY made a short appearance, also SV0WMM/JY, both being approved for DX credits. By far the most interesting operation is by a station calling himself simply JY1. And who is more qualified to call himself JY1 than the King of Jordan, King Hussein, who is the operator concerned. He has been operating at around 14302 from 1800z to 1930z. He has a fast QSL service, and I understand that the actual card, which measures 6 x 4 inches, is a beauty.

Mentioned earlier about the good band conditions we have been experiencing of late, and it is of interest to note the sunspot count. It would seem that the rate of decline has slowed down, for in September last the confirmed number was 81, the November confirmation was 88, confirmations for this year are not to hand as yet, but forecasts for March, April and May are 81, 80 and 79 respectively.

Roy ZM1AAT/K on Raoul Is. is very active on all bands with his 1,000 ft. leg vee beam on Europe. When more wire arrives, he plans to extend his system to favour Africa. Since he commenced operations from this QTH, Roy has had almost 20,000 contacts, and manager George ZM2AFZ has the QSL chores up to date.

Barry ZM1BN/A has now returned home from Snares, and is again active from home QTH on 80 metres. During his stay he made some 2,000 contacts and, again, George has cleared all QSLs to 15th March.

Lester ZM3PO/C is still active on the advertised frequencies, but operating schedules are governed by his work commitments. QSLs are a little slower than the others due to printing difficulties.

Neil VR1Q, in the Gilbert and Ellice group, will be shortly going QRT and returning to Australia after a short stop in New Zealand. His QSL manager is WA3ATP, but George ZM2AFZ is holding his logs to 30th Sept. last should anybody need a QSL. His address is George Studd, 48 Nuffield Ave., Napier, N.Z., and an I.R.C. would be appreciated for direct replies.

Another from George is AX0LD on Macquarie Is. Operator, Harold, is not very active at present, but skeds ZM2AFZ for log exchange 0745z Thursdays on 14112. Anybody wanting a contact with Harold, just break in after the log exchange is completed.

Brian VR4EZ, over in the Solomons, is back on the air after a three months' break, and will be spending a lot of his time at seat with commercial equipment, operating /MM and /P in the course of his duties. You may QSL him to manager W2CTN, or direct to P.O. Box 9, Honiara, Guadalcanal, Br. Solomon Is. Brian will QSL correct s.w.l. reports, but he prefers these to be sent to his home QTH rather than via the manager, and like all DX stations, would appreciate the courtesy of an I.R.C. I have often heard criticism of stations who ask for an I.R.C. or S.A.S.E., but as Brian points out, he has handled up to 140 QSOs in one night when the dogpiles were heavy, and up to 60 in one sitting. Return postage on an operation like this can be expensive, and I should imagine quite annoying when the mail brings forth a pile of valueless and unwanted s.w.l. reports. Don't get me wrong chaps, I'm not saying that all s.w.l. reports are unwanted or valueless, but let's face it, a popular DX station who has worked all parts of the globe certainly doesn't need a card from a listener to tell him how he is getting out. It is amazing the number of cards which find their way into my box for outward despatch, some of these come from all parts of the world and if I didn't have a moral obligation to send them on, I would file them in the w.p.b. with pleasure. Many don't have three of the basic facts on them.

Enough of the complaints and on to the DX. John ZK1AJ has been putting a beautiful signal into this country, at present from Raratonga, however on receipt of a portable generator, he will QSY to Manihiki as ZK1MJ, thence to ZM7. QSL manager for all times is Ed KH6GLU, who is well known as net control for the Pacific DX net. I did, however, get my QSL direct from him at Box 90, Raratonga, Cook Is.

Jeff VK9LB is still active from Norfolk Is. and can be found on Sundays at 0615z 14185 s.s.b., and on 21390 s.s.b. at 1030z. He has been heard in the U.S.A. on 28553 s.s.b. at 2241z. QSL address: J. Liebgold, Box 223, Norfolk Is., South Pacific.

A note re LX1BW ,the only genuine one is the s.s.b. operation; the c.w. is phoney. His operating times are from 1900 on 20 metres daily, 7095 s.s.b. at the week-ends from 0600z, and hopes to be on 80 metres from mid May. QSL to W3HNK.

On Martinique, FM7WN has a sked with his manager W4NQM on 21254 at 2200z daily. Manager prepares a list of Asian stations wishing to contact the FM7.

PY7AWD/0 is operating from Fernando de Noronha, and hopes to be there until December. He is QRV 14150 and 250 from 2000-2359z, also Sundays from 1600z. QSL direct to Carlos Alberto de Araujo, Box 2, Fernando de Noronha.

We are sorry to learn of the death of W4ECI, Everett C. Atkerson, who passed away as the result of a heart attack on 7th March. A top line operator himself, he is possibly better remembered as the QSL manager for the early DX-peditions of Gus W4BPD and Don Miller W9WNV, and trips sponsored by the World Radio Propagation Study Assn.

SV0 operation is not so rare these days, but is sometimes difficult to know exactly where they are operating from. Two regulars are SV0WDD, of Crete (QSL to WA3HUP), and Ike SV0WU who is often found on 14245 s.s.b. at 1730z, or 21295 from 1800z. QSL to Isaac Murphey, U.S. Embassy-VOAR, A.P.O., New York, 09223, or via Box 66, Rhodes for SV0WU.

There is some reported activity by ZM7AF from Nukunono Is. in the Tokelaus group. This chap operates a.m. only and cannot copy either c.w. or s.s.b. For what it is worth, he is crystal controlled on 7060 and 7160.

VE1ASJ, Andy, Box 51, St. John, New Brunswick, Canada, is manager for KG4DO, HP9FC/MM, HR2GK, HR1KAS, VP7NF and VP8JT. Also listed is HQ2RK which you may take or leave.

VO2AW has been re-issued to another operator, and any cards for him should go to the VO2 QSL Bureau, Box 232, Goose Bay, Labrador, Canada. Cards for the previous operator (Don Welling) who went QRT in July 1968, should go direct to him as VE1ACU.

There has been a change in the call signs for the many Russian club stations, which now use the prefix UK. All new calls will have three letters after the prefix, regardless of whether they are clubs or not, however the latter will use the UK prefix regardless of location, which is determined by the first letter after the numeral. For example, the old UP2KAA now becomes UK2PAA, UO5KAA would be UK5OAA, etc. UK0A and UK0B were special club stations in the U.S.S.R., operating in December last.

QSL INFORMATION

The following stations can be reached via the I.S.W.L. QSL Bureau, Eric Chilvers, 1 Grove Road, Lydney, GL15-5JE, Glos., England.

VE3s FAW, GBB, GCO, GNP; VE6s AP, MN, WU, AKP, AKR, AWJ; VE7s CE, SB, AIJ, AZG, BCJ; VE8ZZ, VE0NV, VK2BXF, VKs 3YD, 4HX, 6AJ, 6OV; VO2DK, VP2AB, VP5RS, VP7CC, VQ8AD, VU2DK, W1BB, W1IP, W1ETP, WA1FHU, WN1LOS, W1VKZ, W2CP, W2HL, W2TP, WA2BEX, W2BLQ, W2BOT, WA2BVU, WB2CKS, W2CVW, WA2DHF, W2EQS, W2FLK, WB2FNT, W2HTI, WB2IGM, W2IRV, WB2ISX, XE1YG, 2BM, 0GFJ, 0QDC; YA5RG, YN1TAT, YS1JL, ZB2AV, ZD5X, ZD8CC, ZF1ES, ZL1HW, 1TZ, 1APZ; ZP5DD, 4X4CY, 5H3LV, 6O1WF, 8R1P, 9G1HM, 9J2BC, 9M4LP, 9V1PJ, 9X5AA. There are a large number of Ws which I will give you in a latter issue. I suggest you award hunters keep a note of these calls, as there is a very good award based on them.

SOME QTHs

ET3ZU—Box 379, Asmara, Ethiopa.
FR7ZU—J. Quillet, 6 ave de la Gare, St. Andre, Reunion Is.
IS1VEA—C.P. 25, Cagliari, Sardenga, Italy.
K4CFB—8713 McNair Drive, Alexandria, Va., 22309, U.S.A.
MP4TCE—Box 176, Sharjah, Trucial States, Arabian Gulf.
MP4TCZ—As above.
PY7PO—CP341, Recife, Pernambuco, Brazil.
TJ1AT—Claude Deltiel, B.P. 173, Garoua, Cameroub Rep., Africa.
UA9VH/JT1—Box 639, Ulan Bator, Mongolia.
VP2EQ—Royal Signals A.R.C., B.F.P.O. 643, London.
VR4EJ—P. Butler, C/o. B.S.I. Broadcasting Stn., Honiara, B.S.I.
VU0DK—Box 104, Poona, India.
YA1SG—Steve Garwood, USAID, American Comm. Sch., Lashkargah, American Embassy, Kabul, Afghanistan.
YA2HWI/1—Box 638, Kabul.
YB1AK—Box 288, Bandung, Indonesia.
WB4ICJ—Kennedy Space Centre A.R.S., Box 21073, Kennedy Centre, Florida, U.S.A.
ZD7SD—W. Stevens, P.O. Jamestown, St. Helena.
ZS3HF—Hans Fischer, Box 5011, Windhoek, South West Africa.
9U5DL—B.P. 92, Bujumbura, Burundi, Africa.
9Y4VS—Box 1169, Port of Spain, South America.
5L2D (or EL2D)—Richard Miller, Box 98, Monrovia, Liberia.

TOP BAND ACTIVITY

Tucked away in a corner of Monitor for January is the report of a contact between G3IGW on 1837 KHz. and VK5KO on 1802 KHz. VK5KO was heard 559 and G3IGW heard 339. The time was 2047z to 2053z, and the date was during the second week in December. Very nice work.

Acknowledgment of copy to George ZM2AFZ, Brian VR4EZ, Jack AX3AXQ, Barry AZ5BS, Ernie Luff, Maurie Cox, Maurie Batt, George Allen, Mac Hilliard, Stew Foster of the I.S.W.L., "Monitor," Geoff Watts DX News Sheet, and Long Is. DX Assn. 73 for now, Don.

Overseas Magazine Review

Compiled by Syd Clark, VK3ASC

"BREAK-IN"

January-February 1970—

Australis Oscar 5. (Information reprinted from W.I.A. Newsletter.)

Observations from Australis Oscar 5, K8VTR. Reprinted from "A.R." Dec.

Solid State Circuits for S.S.B., ZL2BDB, Part One. Transceiver design considerations and development of the circuitry.

Diode Amplitude Stabilised V.F.O., ZL4IO. Using parts from disposals sources such as a capacitor from a Command set and a ceramic former from what looks like a piece of A.W.A. gear, Bert has produced a v.f.o. which gave a constant output of 250 mV.

The Quiet Spectrum of 1920, ZL2AZ. A series of historical reminiscences by Tom Clarkson.

"CQ"

January 1970—

Souping Up The Old Receiver, W6HPH. A great deal can be done to up-grade the pre-1960 receiver to meet today's standards. Part 1 of this article deals mainly with the design philosophy of "QRP operation" wherein low power consumption advantages are realised without the disadvantages of transistors.

Radio Row—Japanese Style, W4UW. There is an old adage "birds of a feather flock together". In all great cities it appears that to some extent this is true for businesses of a particular type appear often to concentrate in a fairly well defined area. Akihabara in Tokyo is the place where the Japanese find "everything electronic". More accurately perhaps one should say the full gamut of consumer electrical products, including electronics. Amateurs who visit Japan should not fail to visit this fascinating place. Amateur equipment will not be found on display in the larger stores although some of them have a corner devoted to things Amateur. Look in the back streets nearby for the real gems in shops about 10 or 15 feet wide.

Field Effect Transistors, GW3NJY. Part 2 of this two-part series covers FET characteristics, biasing, circuit configurations, dual gate FETs and FET applications.

An S Meter for the SB34, OZ6LI. Self descriptive. It is good to see papers by foreign Amateurs appearing in the U.S. magazines. Perhaps this is one way of buying a U.S. made piece of gear?

Receiver Signal Handling Capabilities, by W2AEF. The most difficult receiver criteria to explain or comprehend is the ability to handle strong signals on or off the wanted frequency.

Three Bands, One Boom: Another Approach, W1GT. A 3 element Yagi for 14, 2 element Quad for 21 and 28 MHz. in a single compact assembly.

Neutralisation, W8IZH. It is still necessary to neutralise if you want a stable amplifier, and who doesn't. Do not tempt the R.I.

"HAM RADIO"

February 1970—

Strip Line Amplifier/Tripler for 144/432 MHz., K2RIW. Using a 4CX250B, this professional looking design should be able to perform efficiently.

Phase Modulated Transmitter for Two Metres, W6AJF. An interesting design featuring solid state devices, narrow bandwidth, low power consumption.

A Survey of Solid State Power Supplies, W6GXN. Regulated power is a must for today's new circuits. This report deals with some new devices and their applications.

Increasing the Reliability of Warning Lights, W3NK. Equipment warning lights must be reliable. The author indicates that reducing the applied voltage by about 25 per cent. increases the lifetime by about 20 times.

Build Your Own Tilt-Over Antenna Mast, W6KRT. Made from tubular steel, this 30 ft. mast, which is stated to be suitable for a TA33 Jr. (stated to weigh 20 lb.), should also suit a lightweight triband Quad, uses two lengths of 1½ inch water pipe and some oddments of other sizes. Full stress analysis is given together with complete parts lists. (Screw anchors by Langers are available from F. & J. Slegers Products, Ferntree Gully, Vic.) A practical design which can probably be improved by using thin walled, high tensile steel tubing instead of water pipe.

A Different Approach to Amplitude Modulation, WA5SNZ. With regulated power supplies required for modern solid state transmitters, it is a simple thing to modulate the r.f. amplifier power supply.

Antenna Systems for 80 and 40 Metres, by K6KA. Some interesting ideas for efficient broadband antennas for the lower frequency bands.

Quick Band Change from Six to Two Metres, K0VQY. If you operate both bands and require rapid changeover, this scheme will permit you to make it almost instantaneous.

"HAM TIPS"

This R.C.A. booklet is available in Australia from Messrs. A.W.A. Ltd.

December 1968—

A Single Gate MOSFET Pre-amplifier for the Two Metre Band, W2OKO.

November 1969—

A Precision Three Mode Voltage Calibrator, WB2EGZ. For calibrating v.t.v.m's and oscilloscopes.

"CQTV"

November 1969—

Published by the British Amateur Television Club. This issue contains:

A Simple Sync. Pulse Generator, GW6JGA/T. CCIR 625 line too.

A Simple Video Processing Unit, GW6JGA/T. This small publication caters for the needs of the Television Amateur.

MULLARD "OUTLOOK"

Sometimes your reviewer is asked to look over magazines which are "of interest to Amateurs" but which are not "Amateur magazines". Because the input is likely to increase to unmanageable proportions, both for the reviewer and the publisher of "A.R.," I have been reluctant to offer review of other electronic journals.

Over the years Mullard Ltd. could probably be classed as well disposed towards Amateurs and therefore this month I propose to say a few words about their "Outlook," Australian edition for Sept.-Oct. and Nov.-Dec. Anyone in the electronics industry interested in receiving "Outlook" on a regular basis should contact his closest Mullard office.

The issues to hand detail the latest electronic devices on offer from Mullard and contain informative technical articles on Colour Television Part 7 of "A Solid State Colour Television Receiver". Electronics in Domestic Appliances Part 3, "Simple Speed Control and Lamp Dimmer Circuits". Light Units in SI. The subject here is the standardisation of international units. Spark Gaps for Protection of Radio Receivers. The final article deals with a Power Supply with Overload Protection for 20/40W. Amplifier.

On page 63 of the Sept.-Oct. issue is described a new numerical indicator tube, the "Pandicon" ZM1200 14 decade type with only 27 connections. Truly an "integrated" indicator.

The Nov.-Dec. issue deals with such subjects as BRY39 Silicon Controlled Switch as a Relaxation Oscillator, Magnetic Units in SI, Digital Integrated Circuit Applications Part 1, Economical Multivibrator and Monostable Circuit using FC gates. A number of new products are announced, one which could be of great interest to v.h.f./u.h.f. enthusiasts, is titled BLY53A Power Transistor in 470 MHz. Mobile Telephone Transmitters (output power is six watts).

Jan.-Feb. 1970—

Digital Integrated Circuit Applications Part 2. Reversible decade counter with minimum number of TTL packs.

Mullard Pot Core Substitution. The latest gen on Vinkors.

Junction Field Effect Transistors, Their Structure and Operation. The how and why of FET operation.

"QST"

January 1970—

Etched Circuit Boards, W1CER. Tells how to make them at home.

Transistor Module for S.S.B. Transceivers, ON5FE. A complete i.f. and audio system. The KVG 9 MHz. filter is used. (Available from a distributor in N.S.W.) A.f. output is 2.5 watts for a 50 uV. 9 MHz. input. R.f. out 12v. p-p.

Rugged Two Metre Repeater Antenna, by W1HDQ.

Let's Talk Transistors, Part 3. The semiconductor diode. By R. E. Stoffels.

Instant Frequency Change Transceiving with the SB-301 and SB-401. WA8MHO. The author conducts his readers through the drill to modify this combination permitting switch selection of two transceive frequencies.

A Co-axial Band Checker, W1ICP. An absorption type wavemeter which is connected into the co-axial line and designed to be as much a part of the transmission system as an s.w.r. meter.

Antennas for Eighty Metre DX, K2RBT/6. Especially for the farmers.

Allied A-2516 Receiver. A tuneable i.f. type receiver using seven multi-purpose valves. This covers all Amateur segments between 3.5 and 30 MHz. It is sold in Australia under the TRIO label.

Australis Oscar 5. When to listen by WA1IUO and WA2INB. Frequencies are 29.450 and 144.050 MHz.

February 1970—

Historical articles of interest to the whole fraternity appear in the literature from time to time. In this issue of "QST" the front cover is devoted to "Old Timers" admiring a display of historic pieces of radio equipment at a recent convention of the Antique Wireless Association. It is perhaps a great pity that much of the equipment designed, built and used by the pioneers of radio and electronics has completely disappeared.

Equipment Modification for the Blind, W0GS. Although the proper kind of equipment is essential, there is more to helping the sightless Amateur than supplying just the electrical necessities. Article devoted to "Tuning and Operating Procedure".

A Sturdy Eighty Foot Mast, VE7BRK. The mast described here has withstood winds of typhoon velocity without damage. Included in the article is a discussion of a method of accurate antenna matching. All in 2 inch pipe.

How to Wind Your Own Power Transformer, W1ICP. One way of keeping costs down. If adapting this article for use on 50 Hz., be sure and make allowance for the lower frequency.

Long Delayed Echo, W6QYT and others. A report on long delayed echoes (LDEs) by way of a sequel to the author's article in May 1969. (Reprinted in "A.R.," Feb. 1970.) Forty plus reports have been received and details are tabulated.

Another Look at Your Receiver and its S Meter, W4PPB. A useful device which is often misused or its readings misinterpreted.

Let's Talk Transistors, Part 4. The Transistor, by Robert E. Stoffels.

Some Hints on Push Pull 432 MHz. Power Amplifiers, W1HDQ.

Equipment Review. Lafayette HA-800 receiver. Since these are on sale in Australia, some VKs and ZLs will probably be interested.

"RADIO COMMUNICATION"

January 1970—

Where T.V.I. is a Problem, Build This Top Band to Ten S.S.B. Transmitter, G3HVA. A valve job using a 7360 balanced modulator and 9 MHz. filter. The output stage uses a pair of 5B/254M valves (made by S.T.C., these have characteristics similar to the 807 but they are in a smaller envelope). Power output is stated as 180w. p.e.p.

A Transistor S.S.B. Transmitter for Top Band, G3UFW. QRP about 5w. peak input.

Beam Recovery, G5GH. Describes a unit for removing and erecting the beam onto the top of a fixed triangular lattice mast.

Technical Topics, G3VA. This is a feature of "Radio Communication" which is always read with great interest. Pat Hawker culls through all the literature available to him and comments on any matters which appear to be of interest to Amateurs. This month he covers the history of the sixties, briefly, discusses "Thyristor Power Supplies," "Safety First," "Transistor Mixers," "Hot Carrier Diode Product Detector" (using the HP2800 series which sell for about $1.20 each). Pat concludes with "Components of the Seventies" and a note about G2BW who has been using a 2PL Special Aerial described in "TT" July 1968.

"RADIO ZS"

January 1970—

Jamboree on the Air, ZS6XK. The South African National Organiser tells of the way they organised matters and the results achieved during the annual "Scout Co-operation Weekend" in 1969.

English seems to be giving way to Afrikaans in "Radio ZS" and so it is becoming more difficult for people like your reviewer to understand.

(continued on next page)

"SHORT WAVE MAGAZINE"

January 1970—

One Man Forty Foot Mast and Beam Assembly, 9HIR/G3WNZ. Another method of supporting the "Antenna Farm". This assembly is hinged at the base in a simple manner and makes use of the eaves of the house to provide a suitable location for two of the guys which are taken through a common double pulley for ease in hoisting and lowering. The rotator is fitted half way up the mast.

Economical A.M. Phone on Two Metres, G3YUA. A QQV06/40 r.f. amplifier which is series gate modulated, is described.

Versatile A.T.U. for Top Band, G3UGK. A multi-match device for any type of aerial.

Investigating V.H.F. Propagation Effects, by R. Ham. Amateur installation for observation on tropospheric anomalies, sporadic E, aurora and solar flares.

"73"

January 1970—

Single Sideband AM-FM Modulation System, W2BSP. Using easily available filters.

The Transceiver Companion, W6AJZ. Does everything but change the baby.

A Simple Bench Power Supply, ZL2AMJ. For those readers with simple benches.

Slow Scan Colour Transmission, W. Tarr and W4UMF. See cover of "73" for illustration of results.

Fascinating Fundamentals — Volta and His Piles, W2FEZ.

The Manuscript Game, K6MVH. Another construction article flushed out.

Base-Tuned Centre Loaded Antenna, W2EEY. Vertical antennas are not basically bad.

Quazar QRP 40 Metre D.S.B. Transmitter, WA5WWN. Solid state to boot.

Simple Compact Six Metre Bandpass Filter, WA5SWD/6. Cuts down your channel 2 DX.

Low Cost Electronics: Japan's F.M. Invasion, K6MVH. F.m. changes from surplus to imports.

Mobile C.w., K6RA. On the freeways, no less!

Extra Class Licence Course, Part XII., Staff. Semiconductors. Last chance to learn this.

A Preamplifier for Ten Metre Band, by WA3HMN. Also works on C.B., but don't tell anyone.

Proper Use of Silicon Rectifier Diodes, K3DPJ and WA3ACL. Diode poppers, arise and stamp out this stuff.

Converting the 4CX1000A into a Lamp, K3QKO. Excellent application for your spare tubes.

Facsimile and the Radio Amateur, K6GKX. Are you missing out on FAX fun?

Tunable Solid State I.F., K1CLL. 28-30 MHz. i.f. for use with u.h.f. converters.

February 1970—

Fascinating Fundamentals. The Terrible Jar at Leyden. W2FEZ.

18 Inch Dipole on 15 Metres, K9LGH. February fool article? Heh! Heh! (A shortened Joystick.)

High Performance Converter for Six, by WA9HES. "73" drags its heels into the 70s with a tube.

From Breadboard to Printed Circuit—The Easy Way, K1AOB. And it is easy for once.

The Camper: Mobile and Portable, WA9EHE. En-radio-fying the VW bus.

So You Think You Have Troubles? W1EMV. Cutting blind Amateur's antennas for fun.

Frequency Synthesis — The Modern Way, W2EUP. Special book-length feature for f.m. fiends.

Encoding and Decoding in F.M. Repeaters, W6ZCL/K6MVH/W6TEE. Three parts.

How to Visit Foreign Countries, W2NSD. Using Amateur Radio to make travel funnier.

The DX-35 Revisited, W2AOO. Exciting development for chirp haters.

Panoramic Receiver for V.H.F., I1SLO. For two metre busy-bodies.

Variable Impedance Mobile Mount, W1EMV. Out, damned reactance!

Lossy Transmission Lines, KH6IJ/1. A shorty short.

Extra Class Study Course, Part 13. R.t.t.y., f.s.k., filters, etc. "73" Staff.

New Linear ICs for the Ham, WA4KRE. Cheap, new, hot—have fun.

The Glop Will Get You If You Don't Watch Out! W2ELU. Watch out!

The Micromitter, WA3GGH. The world's cheapest rig.

A Simple IC Q-Multiplier, W2EEY. Makes the c.w. band ten times wider.

Quick Stop and Reversing Action for Antenna Rotors, PY2AUC. Whipping the antenna whip. (Probably better described as dynamic braking.)

(All the above comments are "73's".)

NEW CALL SIGNS

DECEMBER 1969

VK1DH—Deakin High School Radio Club, Kent St., Deakin, 2600.
VK2SH—D. R. Gill, 14 Churchill St., South Tamworth, 2340.
VK2AAD—N. C. Drummond, Station: 63 High St., Wauchope, 2446; Postal: P.O. Box 7, Wauchope, 2446.
VK2AAL—J. C. Bennett, 6 Highview Ave., Greenacre, 2190.
VK2AAY—P. G. Broughton, Sylvan Ave., East Lindfield, 2070.
VK2ACJ—W. W. Ellis, Menzies Hotel, Sydney, 2000.
VK2ANI—U. N. Fierz, 3/2 Lindsay Ave., Summer Hill, 2130.
VK2ANX—J. W. Rothenbury, 20 Atkins Rd., Ermington, 2115.
VK2ARX—W. M. C. Quinlan, 152 Sherbrook Rd., Asquith, 2078.
VK2ASE—A. A. Smith, 12 Vincent St., Baulkham Hills, 2153.
VK2AZA—K. E. C. Gillon, 552 Mowbray Rd., Lane Cove, 2066.
VK2BAD—A. Davis, 25/19 Charles St., Queanbeyan, 2620.
VK2BWM—W. M. Groves, 21 Allambie Rd., Castlecove, 2069.
VK2ZAJ—W. G. Gummerson, 13 Hindmarsh Rd., Liverpool, 2170.
VK2ZCE—A. Harrison, 52 Flinders St., Wagga Wagga, 2650.
VK2ZCS—M. G. Williams, Lot 60, Knox Rd., Doonside, 2767.
VK2ZEP—P. J. Smith, 35 Princess St., Brighton Le Sands, 2216.
VK2ZEX—C. G. Woolston, 21 Eulabah Ave., Earlwood, 2206.
VK2ZFG—D. J. Upton, Station: 42 Esk Ave., Charlestown, 2290; Postal: 7/23 Unara St., Campsie, 2194.
VK2ZHE—H. D. Lundell, Station: 23 Tacking Point, Pt. Macquarie, 2444; Postal: R.M.B., 23 Tacking Point, Pt. Macquarie, 2444.
VK2ZIK—A. F. Sara, 20 Khartoom Ave., Gordon, 2072.
VK2ZJO—J. F. Barker, 51 Beale St., Georges Hall, 2198.
VK2ZLF—L. W. A. Doolan, 130 Rae Cres., Kotara South, 2288.
VK2ZPY—P. J. Larkin, 10 Herbert St., Rockdale, 2216.
VK2ZSB—R. K. Graham, 13/818 Victoria Rd., Ryde, 2112.
VK2ZSC—S. W. Castle, 45 O'Keefe Cres., Eastwood, 2122.
VK2ZSI—R. R. Iwasenko, 3 Rosedale St., Canley Heights, 2166.
VK2ZSO—G. R. Johns, Flat 5, "Cahill Court," Flint St., Forbes, 2871.
VK3AV—R. H. Leskie, 15 Cecil St., Horsham, 3400.
VK3AJG—W. M. Nicholson, Lot 1470, 8 Giselle Crt., Karingal, 3197.
VK3ALE—V. J. Burden, 6 Glendale St., Surrey Hills, 3127.
VK3AWL—R. V. Reid, 17 Norman St., East Doncaster, 3109.
VK3BAU—I. C. Beulke, 228 11th St., Mildura, 3550.
VK3YAV—F. Egan, 17 Carson St., Kew, 3101.
VK3YAZ—P. R. Johnstone, 65 Karnat Rd., Ashburton, 3147.
VK3YBD—B. Cockran, 9 Service Rd., Moe, 3825.
VK3YBS—W. L. Sides, Lot 11, Mackintosh Rd., Glen Waverley, 3150.
VK3YCA—F. V. Hughes, 6 James St., Morwell, 3840.
VK3YCF—A. Shelamoff, 11 Milford St., East Bentleigh, 3165.
VK3YCQ—K. E. Purchase, Lot 1, Canterbury Rd., Bayswater, 3153.
VK3YCS—P. J. Rice, 54 Playne St., Heathcote, 3606.
VK4HG—H. J. Hicks, C/o. Overseas Telecommunications Station VII., Thursday Island, 4875.
VK4YT—N. J. Watling, Hibiscus Lane, Holloways Beach, via Cairns, 4870.
VK4ZAC—A. R. Rettke, 52 Mayhew St., Sherwood, 4075.
VK4ZIB—I. B. Baty, 22 Christensen St., Machan's Beach, 4870.
VK4ZPU—P. S. McWhinney, 222 Victoria Ave., Margate, 4019.
VK5AS—G. J. Hambling, 39 Tapleys Hill Rd., North Glenelg, 5045.
VK5DI—R. G. R. Dobson, 16 Howden Rd., Fulham, 5024.
VK5ZIJ—I. J. Crawford, 31 Nimitz Rd., Elizabeth East, 5112.
VK6AP—J. P. Marks (Bro.), Aquinas College Manning, 6152.
VK6BD—B. F. J. Davis, 29 Amherst St., Midland, 6056.
VK6BX—D. V. Hambleton, 116 Astley St., Gosnells, 6110.
VK6FT—F. T. Tuffin, 38 Elmwood Ave., Woodlands, 6018.
VK6KQ—H. Sims, Shell Roadhouse, Great Eastern Hwy., Cunderdin, 6407.
VK6KY/T—G. D. Ogg, 50 Milton St., Mt. Hawthorn, 6016.
VK6LI—W. F. Cashwell, U.S. Navcommsta, P.O. Box 22, Exmouth, 6707.
VK6PG—A. J. Gibbs, 11 Grant Pl., Bentley, 6102.
VK6PR/T—R. T. Fisher, 48 Purslowe St., Glendelough, 6016.
VK6PX—P. V. West, 255 Fulham St., Cloverdale, 6105.
VK6VE—V.h.f. Group of W.A., Station: Mt. Barker Hill; Postal C/o. T. C. Berg, 23 Beach St., Bicton, 6157.
VK6ZB—B. Taylor, 233 Preston Point Rd., Bicton, 6157.
VK6CIB—K. M. Moore, Station: Portable; Postal: 40 Collingwood St., Dianella, 6062.
VK6ZDM—C. R. Burton, Flat 12, 19 Raymond St., Tuart Hill, 6060.
VK6ZGB—R. A. Rodgers, 21 Lilian Ave., Applecross, 6153.
VK6ZGW—K. J. Chipper, 20 Bindaring Pde., Cottesloe, 6011.
VK7JA—J. P. Agnew, "Waverley," Oatlands, 7205.
VK7KM—K. G. McCraken, 29 Esplanade, Montague Bay, 7018.
VK7ZPA—P. M. Cox, 7 Winmarleigh Ave., Taroona, 7006.
VK8CP—I. P. Cork, Flat 2, 1323 Casuarina Dr., Nightcliffe, 5792.
VK8GT—G. R. Thompson, 2 Hablett Cres., Alice Springs, 5750.
VK8KA—K. J. Assender, 2 Lampe St., Fannie Bay, 5790.

CANCELLATIONS

VK1DA—A. Davis. Now VK2BAD.
VK2SS—T. Ivins. Transfered to T.P.N.G.
VK2AYD—D. G. Taylor. Transferred to Vic.
VK2ZGB—J. C. Bennett. Now VK2AAL.
VK2ZHB—B. Hobbs. Not renewed.
VK2ZPU—P. S. McWhinney. Now VK4ZPU.
VK2ZWQ—W. M. C. Quinlan. Now VK2ARX.
VK3AV—J. L. A. Martin. Deceased.
VK3AAX—F. Rogers. Not renewed.
VK3ALN—A. S. W. Taylor. Not renewed.
VK3AMY—W. R. McLaughlin. Transferred to Qld.
VK3ASN—K. J. Assender. Now VK8KA.
VK3AQU—R. H. Leskie. Now VK3AV.
VK3BAI—R. E. Maricle. Not renewed.
VK3YAI—P. R. Johnstone. Now VK3YAZ.
VK3YBI—I. C. Beulke. Now VK3BAU.
VK3ZDD—R. V. Reid. Now VK3AWL.
VK3ZHG—G. R. Hovey. Transferred to A.C.T.
VK3ZRG/T—R. G. Thomas. Now VK3BAS/T.
VK5IR—G. R. Thompson. Now VK8GT.
VK5RC—J. Reilly. Not renewed.
VK5ZBG—G. J. Hambling. Now VK5AS.
VK5ZDG—J. E. S. Day. Transferred to Vic.
VK6AU—I. A. E. G. Norman. Not renewed.
VK6DG—D. R. Garratt. Transferred to Vic.
VK6KM—K. M. Moore. Now VK6CIB.
VK6LD—L. A. Dancey. Transferred to Qld.
VK6RZ—R. K. Philstrom. Not renewed.
VK6WV/T—Western Video & Transmission Club. Not renewed.
VK6ZAG—J. P. Marks (Bro.). Now VK6AP.
VK6ZBT—B. Taylor. Now VK6ZB.
VK6ZDF—R. T. Fisher. Now VK6PR/T.
VK6ZDQ—M. E. Zile. Not renewed.
VK6ZDW—D. J. Wauchope. Not renewed.
VK6ZES—S. J. Sands. Not renewed.
VK6ZEU—P. V. West. Now VK6PX.
VK6ZGG—F. T. Tuffin. Now VK6FT.
VK6ZGO/T—G. D. Ogg. Now VK6KY/T.
VK6ZKZ—D. V. Hambleton. Now VK6BX.
VK7NB—N. Bolland. Transferred to T.P.N.G.
VK7ZBA—J. P. Agnew. Now VK7JA.
VK7ZHH—H. F. Hutchinson. Not renewed.

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CONTEST CALENDAR

16th/17th May: Sangster Shield, 3.5 MHz. only (N.Z.A.R.T.).
4th/5th July: Memorial Contest, 3.5 MHz. only (N.Z.A.R.T.).
15th/16th August: Remembrance Day Contest (W.I.A.).
3rd/4th October: VK/ZL/Oceania DX Contest, Phone.
10th/11th October: VK/ZL/Oceania DX Contest, C.w.
10th/11th October: R.S.G.B. 28 MHz. Phone Contest.
24th/25th October: R.S.G.B. 7 MHz. DX Contest, C.w.
7th/8th November: R.S.G.B. 7 MHz. DX Contest, Phone.

—D. H. Rankin, F.E.

Correspondence

Any opinion expressed under this heading is the individual opinion of the writer and does not necessarily coincide with that of the Publishers.

REPLY TO "SIT AND THINK"

Editor "A.R.," Dear Sir,

I must comment on a letter published in April "A.R." headed "Sit and Think".

Scene 1 and Scene 3 need more thought on the part of the writer of the letter.

Re Scene 1: How can altering a call sign in a contact already established give "another contact"?

Re Scene 3: Capt. Cook certainly did NOT discover the East Coast of Australia, it had been discovered decades before Cook's voyage. What Cook did was to produce the first charts of any accuracy.

I, also, don't use the AX prefix unless asked to use it, which I then do, amused that the operator at the other end gets any satisfaction that I did—it takes all sorts!!!

—Keith McCarthy, VK9AR.

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FEDERAL AWARDS

COOK BI-CENTENARY AWARD

The following additional stations have qualified for the award:—

Cert. No.	Call	Cert. No.	Call	Cert. No.	Call
104	AX2AIA	131	OA4QZ	157	ZM1AZN
105	ZS5FF	132	ZM3BK	158	JA6JDP
106	ZM3RS	133	G3YNC	159	ZM3BV
107	AX3SM	134	G6LK	160	W3HQU
108	W3GHD	135	CT1UA	161	ZS5LB
109	DJ8YQ	136	KA2ZD	162	W6HUR
110	ZM4CA	137	AX7GC	163	VE3BWY
111	KA2QW	138	AX9KY	164	VE3EWY
112	7Z3AB	139	4X4KM	165	AX5HY
113	G3AMM	140	W4BSB	166	W9FD
114	9Y4PL	141	VU2BEO	167	AX3PY
115	YV5AK	142	XE1IX	168	HC2SO
116	CP1HW	143	AX3PR	169	AX5LC
117	W6AC	144	F2MA	170	G2SB
118	WA5TYX	145	AX7LZ	171	G3NOF
119	W8ZOK	146	ZM1UR	172	9V1PM
120	ZM2AYI	147	G2CCD	173	WA0VZF
121	AX4VC	148	ZL3ADF	174	G6RC
122	CE5DF	149	PJ2CW	175	VP7CG
123	AX3ARV	150	AX3JM	176	ZM2BCX
124	ZM1DD	151	AX6HJ	177	PY3APH
125	OA4J	152	ZM1BGV	178	AX5NB
126	AX2AHH	153	W2NHZ	179	AX3SO
127	AX2ABZ	154	G6TA	180	AX2AFI
128	VR1V	155	K2BJB	181	AX3BCN
129	AX4BG	156	AX3APU	182	AX4ZW
130	VE3OI			183	AX3ADO

W.I.A. V.H.F.C.C.

Cert. No.	Call	Confirmations 52 MHz.	144 MHz.
	New Member		
72	VK5ZMT	106	—
	Amendments		
44	VK3AMK	151	—
46	VK3ZNJ	242	—
47	VK3ZNJ	—	268

D.X.C.C.

OJ0—Market Reef. This new D.X.C.C. country has been on the bands recently with several expeditions providing plenty of contacts. Cards for OJ0 are being received and credited as a new country. Full details will be given as soon as possible.

Cook Bi-Centenary Award

(V.H.F.-U.H.F. SECTION)

The following rules were adopted at the Federal Convention of the Wireless Institute of Australia held in Adelaide over Easter. They are an addition to the rules already published and are intended to encourage participation by v.h.f.-u.h.f. operators.

Correspondence from the following people is acknowledged with thanks; their comments and suggestions have been incorporated, where possible, in the final rules:

P. Healy, VK2APQ, Federal Councillor, N.S.W. Division.
G. Taylor, VK5TY, Federal Councillor, South Aus. Division.
T. A. Lane, VK4ZAL.
C. Maude, VK3ZCK.
Townsville Amateur Radio Club.
E. C. Jamieson, VK5LP.

AWARD RULES

Operation.—Only Australian Amateur Stations using the special AX prefix may be worked for the purpose of this award. Contacts may be made on any v.h.f. or u.h.f. band or mode available to Australian Amateur Stations. Cross band operation will not be permitted. No contacts made with ship or aircraft stations in Australian Territories will be eligible, but land mobile or portable stations may be contacted provided the location of the station worked, at the time of the contact, is clearly indicated.

Operators at all times must operate within the terms of their station licence. All contacts must be made during the period 1st January to 31st December, 1970, inclusive. Contestants may work each station once only per band during this period for the purposes of this award. If a station is worked on more than one band, each additional band worked may be counted as a separate contact for award purposes.

Application may be made for one certificate only, either h.f. bands or v.h.f.-u.h.f., but not both sections.

Requirements.—Stations must contact 100 different (except as above where a station is worked on more than one band) Australian Amateur Stations using the AX prefix during the specified period.

Applications. — Stations applying for the award are **not** to forward QSL cards, but instead should submit a list of the stations worked (in order of Call Areas) plus the following details of each contact: Date, Time (GMT), Band, Mode, Report. This list, certified by two other licensed Amateurs, plus a statement to the effect that they have sighted the log entries of the applicant, should be sent to:

Awards Manager, W.I.A.,
P.O. Box 67,
East Melbourne,
Vic., Australia, 3002.

All applications are to be received at the above address no later than 31st December, 1971, as no further entries will be accepted after that date. Certificates will be forwarded, free of charge, by surface mail.

MISSING PERSONS

The R.S.G.B. has asked if we can locate two ex G3s who migrated to Australia some years ago:

Mr. Edward Mitchell, G3GZW/A/P, of 18 Southcote Cres., Essex,

and

Mr. David Hooper, G3ICU, of Caseldene Rd., Harlesden, London.

Any information would be appreciated by their mutual friend, Mr. J. O'Connor, of Ipswich, Suffolk, or direct to Federal Secretary, P.O. Box 98, East Melbourne, Vic., 3002.

HAMADS

Minimum $1 for forty words.
Extra words, 3 cents each.

HAMADS WILL NOT BE PUBLISHED UNLESS ACCOMPANIED BY REMITTANCE.

Advertisements under this heading will be accepted only from Amateurs and S.w.l's. The Publishers reserve the right to reject any advertising which, in their opinion, is of a commercial nature. Copy must be received at **P.O. 36, East Melbourne, Vic., 3002,** by **5th of the month** and **remittance must accompany** the advertisement.

COMPLETE STATION from earth peg to antenna. Swan 500C as brand new. This piece laboratory selected from Swan factory. Complete with latest D10A Astatic Mike, vox unit and power supply. S.w.r. bridge, over 100 ft. co-ax. cable with connectors, etc. 50 ft. 2-section crank-up tower, Ham M Rotator and control box, TH6DX 6 el. triband beam with special wind deflectors on traps. Phone (Melb.) 67-4486, A.H. 24-2043.

EXCHANGE: FTDX-400 Series 2, in excellent condition for FTDX-100. Must also be in excellent condition. VK5XV, 21 Dudley Cres., Marino, S.A., 5049. Phone 96-3136.

FOR SALE: BC221, rough, needs cal., $20; BC433F Compass Rec., less controls, $15; Sig. Gen., 300-1000 meg., variable pulse freq., width, delay, $50; AR7 Rec., needs work, $40; six butterfly capacitors, new, $2 each; Fil. Tranny, 6.3v. at 10 amps., $8; "Marconi" V.T.V.M., $15. 64 O'Grady St., Albert Park, Vic., 3206.

FOR SALE: Complete 20 metre Beam Installation —3 el. on 42 ft. windmill tower, including prop. pitch motor, selsyns and indicator unit, and all co-ax., cables, etc. VK3LW, Phone 45-2141 (Melb.) except 9th-16th May.

FOR SALE: 1 Geloso 222TR Transmitter, first class condx, complete with Inst. Book. Price $75. VK2MW, M. C. Darby, "Tothra," Spring Ridge, N.S.W., 2416.

SELL OR SWAP: Rack mounted a.m. transmitter, separate stages, in alum. boxes. Also 6v. car radio and gen. motor, plus other gear. VK2QB, 20 Catherine St., Kotara, N.S.W., 2288.

S.S.B. ADAPTOR: Heathkit SB-10 with handbook and spare set of valves. Designed for use with Apache but will convert any a.m. transmitter to s.s.b. Has d.s.b., u.s.b., l.s.b., vox, etc. Five bands. Very little use. Can be heard on air. $90. 10 Regent Street, Pennington, S.A., 5013. Phone 42477.

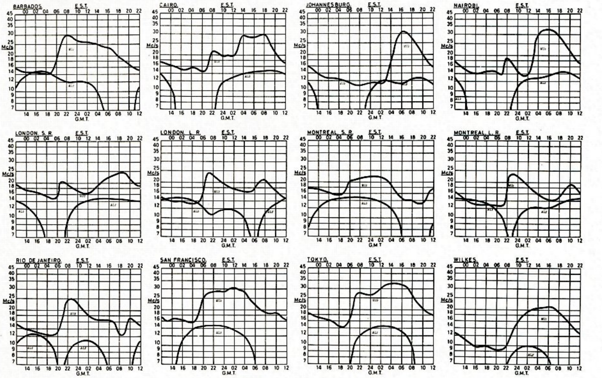
WANTED: Eddystone 504, 680, 680X, 750 or similar general coverage receiver. Also want 14AVQ Vert. Ant. Please contact VK3OM, 3 Fairview Ave., Glen Waverley, Vic., 3150. Phone 560-9215.

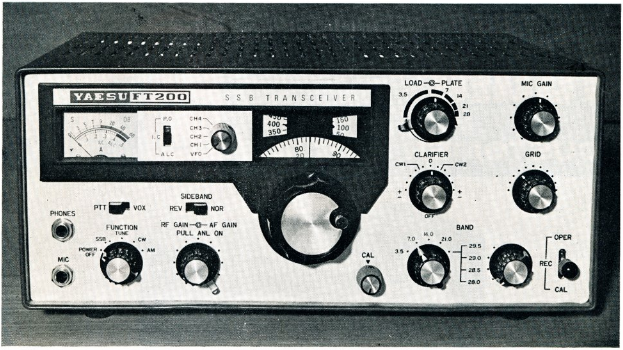
WANTED: One of the following ¼ kw. Q.G. Spark Transmitters: Marconi types 241C, 341, 369, 558, 355, 355F; Radio Communication Co. types PS17, T20, T24, T22, T29, or similar small home-brew equipment. Also quenched plate gap dischargers; high voltage mica condensers such as Admiralty pattern 5001 with rating 0.0044 uF. 20,000 volt test. R. F. Fisher, VK3BAQ, 241 Royal Pde., Parkville, Victoria, 3052.

WANTED: Telescopic Tower to about 35 ft., also FT100 Transceiver. Price, condition and details please to D. Gilder, 20 Grandview Rd., Box Hill South, Vic., 3128. Phone 288-2024.

PREDICTION CHARTS FOR MAY 1970

(Prediction Charts by courtesy of Ionospheric Prediction Service)




YAESU FT200
S S B TRANSCEIVER
LOAD PLATE
MIC GAIN
CLARIFIER
GRID
SIDEBAND
REV NOR
PTT VOX
PHONES
FUNCTION
RF GAIN AF GAIN
PULL ANL ON
MIC
CAL
BAND
OPER
REC
CAL